Configuring Serial Interfaces

Use the information in this chapter to configure serial interfaces.

For information on configuring an Asynchronous Transfer Mode (ATM) interface, see the "Configuring ATM Access over a Serial Interface" chapter in the *Wide-Area Networking Configuration Guide*.

See also the section "Configure the CRC" in the section "Configure a Synchronous Serial Interface" in this chapter.

For hardware technical descriptions and information about installing interfaces, refer to the hardware installation and configuration publication for your product. For a complete description of serial interface commands used in this chapter, refer to the "Interface Commands" chapter of the *Cisco IOS Interface Command Reference*. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

These sections are included in this chapter:

- Configure a High-Speed Serial Interface
- Configure a Synchronous Serial Interface
- Configure a Channelized T3 Interface Processor
- Configure PA-E3 and PA-2E3 Serial Port Adapters
- Configure PA-T3 and PA-2T3 Serial Port Adapters
- Configure a Packet OC-3 Interface
- Configure Automatic Protection Switching of Packet-over-SONET Circuits
- Configure Serial Interfaces for CSU/DSU Service Modules
- Configure Low-Speed Serial Interfaces

For examples of configuration tasks shown in this chapter, see "Serial Interface Configuration Examples" at the end of this chapter.

Configure a High-Speed Serial Interface

The High-Speed Serial Interface (HSSI) Hip Interface Processor (HIP) provides a single HSSI network interface. The network interface resides on a modular interface processor that provides a direct connection between the high-speed CiscoBus and an external network.

The HSSI port adapters (PA-H and PA-2H) are available on Cisco 7200 series routers, on second-generation Versatile Interface Processors (VIP2s) in Cisco 7500 series routers, and on Cisco 7000 series routers with the 7000 Series Route Switch Processor (RSP7000) and 7000 Series Chassis

Interface (RSP7000CI). The PA-H provides one high-speed synchronous serial interface, and the PA-2H provides two high-speed synchronous serial interfaces that support full-duplex and data rates up to 52 Mbps. For more information on the PA-H and PA-2H, refer to the *PA-H and PA-2H HSSI Port Adapter Installation and Configuration* publication.

The Cisco 3600 series 1-port HSSI network module provides full-duplex connectivity at Synchronous Optical Network (SONET) OC-1/STS-1 (51.840 Mhz), T3 (44.736 MHz), and E3 (34.368 MHz) rates in conformance with the EIA/TIA-612 and EIA/TIA-613 specifications. The actual rate of the interface depends on the external data service unit (DSU) and the type of service to which it is connected. This 1-port HSSI network module can reach speeds of up to 52 Mbps in unidirectional traffic with 1,548-byte packets and 4,250 packets per second. Asynchronous Transfer Mode (ATM), High-Level Data Link Control (HDLC), Point-to-Point Protocol (PPP), Frame Relay, and Switched Multi-Megabit Data Service (SMDS) WAN services are all fully supported.

Before you configure the 1-port HSSI network module, complete the following prerequisite tasks:

- Install the HSSI Network Module in a chassis slot. For information on how to install this network module, refer to the "Installing a 1-Port HSSI Network Module in a Chassis Slot" section in the *1-Port HSSI Network Module Configuration Note*.
- Complete basic device configuration, including host name, username, protocol, and security configuration. For more information about basic device configuration, refer to the *Cisco 3620 Installation and Configuration Guide* or the *Cisco 3640 Installation and Configuration Guide*.

HSSI Configuration Task List

Perform the tasks in the following sections to configure a HSSI interface. The first task is required; the remaining tasks are optional.

- Specify a HSSI
- Specify HSSI Encapsulation
- Invoke ATM on a HSSI Line
- Convert HSSI to Clock Master
- Disable Fair Queueing

Specify a HSSI

To specify a HSSI and enter interface configuration mode, use one of the following commands in global configuration mode:

Command	Purpose
interface hssi *number*	Begin interface configuration.
interface hssi *slot*/*port*	Begin interface configuration for the Cisco 7500 series routers.

Specify HSSI Encapsulation

The HSSI supports the serial encapsulation methods, except for X.25-based encapsulations. The default method is HDLC. You can define the encapsulation method by using the following command in interface configuration mode:

Command	Purpose
encapsulation {**atm-dxi** | **hdlc** | **frame-relay** | **ppp** | **sdlc-primary** | **sdlc-secondary** | **smds** | **stun**}	Configure HSSI encapsulation.

For information about PPP, see the "Configuring Asynchronous PPP and SLIP" and "Configuring Media-Independent PPP and Multilink PPP" chapters in the *Dial Solutions Configuration Guide*.

Invoke ATM on a HSSI Line

If you have an ATM DSU, you can invoke ATM over a HSSI line. You do so by mapping an ATM virtual path identifier (VPI) and virtual channel identifier (VCI) to a DXI frame address. ATM-DXI encapsulation defines a data exchange interface that allows a DTE (such as a router) and a DCE (such as an ATM DSU) to cooperate to provide a User-Network Interface (UNI) for ATM networks.

To invoke ATM over a serial line, use the following commands in interface configuration mode:

Step	Command	Purpose
1	**encapsulation atm-dxi**	Specify the encapsulation method.
2	**dxi map** *protocol address vpi vci* [**broadcast**]	Map a given VPI and VCI to a DXI frame address.

You can also configure the **dxi map** command on a serial interface.

To configure an ATM interface using an AIP card, see the "Configuring ATM" chapter in the *Wide-Area Networking Configuration Guide*.

Convert HSSI to Clock Master

HSSI network module provides full-duplex connectivity at Synchronous Optical Network (SONET) OC-1/STS-1 (51.840 Mhz), T3 (44.736 MHz), and E3 (34.368 MHz) rates in conformance with the EIA/TIA-612 and EIA/TIA-613 specifications. The actual rate of the interface depends on the external data service unit (DSU) and the type of service to which it is connected. You can convert the HSSI interface into a clock master by using the following command in interface configuration mode:

Command	Purpose
hssi internal-clock	Convert the HSSI interface into a *51.84-MHz* clock master.

Disable Fair Queueing

Disabling fair queuing will dramatically improve fast switching rates over the HSSI. To disable fair queueing, use the following command in interface configuration mode:

Command	Purpose
no fair-queue	Disable fair queueing.

Configure a Synchronous Serial Interface

Synchronous serial interfaces are supported on various serial network interface cards or systems. These interfaces support full-duplex operation at T1 (1.544 Mbps) and E1 (2.048 Mbps) speeds. Refer to the *Cisco Product Catalog* for specific information regarding platform and hardware compatibility.

Synchronous Serial Configuration Task List

Perform the tasks in the following sections to configure a synchronous serial interface. The first task is required; the remaining tasks are optional.

- Specify a Synchronous Serial Interface
- Specify Synchronous Serial Encapsulation
- Configure a JT2 6.3-MHz Serial Port Adapter
- Configure PPP
- Configure Half-Duplex and Bisync for Synchronous Serial Port Adapters on Cisco 7200 Series Routers
- Configure Compression Service Adapters on Cisco 7500 Series Routers
- Configure Compression of HDLC Data
- Configure Real-Time Transport Protocol Header Compression
- Configure the CRC
- Use the NRZI Line-Coding Format
- Enable the Internal Clock
- Invert the Data
- Invert the Transmit Clock Signal
- Set Transmit Delay
- Configure DTR Signal Pulsing
- Ignore DCD and Monitor DSR as Line Up/Down Indicator
- Specify the Serial Network Interface Module Timing
- Specify G.703 and E1-G.703/G.704 Interface Options

See the “Serial Interface Configuration Examples” section at the end of this chapter for examples of configuration tasks described in this chapter.

Specify a Synchronous Serial Interface

To specify a synchronous serial interface and enter interface configuration mode, use one of the following commands in global configuration mode:

Command	Purpose
interface serial *number*	Begin interface configuration.
interface serial *slot*/*port*	Begin interface configuration for the Cisco 7200 or Cisco 7500 series routers.
interface serial *slot*/*port-adapter*/*port*	Begin interface configuration for the Cisco 7500 series routers.
interface serial *slot*/*port*:*channel-group* (Cisco 7000 series) **interface serial** *number*:*channel-group* (Cisco 4000 series)	Begin interface configuration for a channelized T1 or E1 interface.

Specify Synchronous Serial Encapsulation

By default, synchronous serial lines use the High-Level Data Link Control (HDLC) serial encapsulation method, which provides the synchronous framing and error detection functions of HDLC without windowing or retransmission. The synchronous serial interfaces support the following serial encapsulation methods:

- Asynchronous Transfer Mode-Data Exchange Interface (ATM-DXI)
- High-Level Data Link Control (HDLC)
- Frame Relay
- Point-to-Point Protocol (PPP)
- Synchronous Data Link Control (SDLC)
- Switched Multimegabit Data Services (SMDS)
- Cisco Serial Tunnel (STUN)
- X.25-based encapsulations

You can define the encapsulation method by using the following command in interface configuration mode:

Command	Purpose
encapsulation {**atm-dxi** | **hdlc** | **frame-relay** | **ppp** | **sdlc-primary** | **sdlc-secondary** | **smds** | **stun** | **x25**}	Configure synchronous serial encapsulation.

Encapsulation methods are set according to the type of protocol or application you configure in the Cisco IOS software. ATM-DXI is described in this chapter in the section “Configure the CRC.” PPP is described in the “Configuring Media-Independent PPP and Multilink PPP” chapter in the *Dial Solutions Configuration Guide*. The remaining encapsulation methods are defined in their respective books and chapters describing the protocols or applications. Serial encapsulation methods are also discussed in the *Cisco IOS Interface Command Reference* in the chapter “Interface Commands” under the **encapsulation** command.

By default, synchronous interfaces operate in full-duplex mode. To configure an SDLC interface for half-duplex mode, use the following command in interface configuration mode:

Command	Purpose
half-duplex	Configure an SDLC interface for half-duplex mode.

BSC is a half-duplex protocol. Each block of transmission is acknowledged explicitly. To avoid the problem associated with simultaneous transmission, there is an implicit role of primary and secondary station. The primary resends the last block if there is no response from the secondary within the period of block receive timeout.

To configure the serial interface for full-duplex mode, use the following command in interface configuration mode:

Command	Purpose
full-duplex	Specify that the interface can run BSC using switched RTS signals.

Configure a JT2 6.3-MHz Serial Port Adapter

The JT2 6.3-MHz serial port adapter (PA-2JT2) is available on a second-generation Versatile Interface Processor (VIP2) in Cisco 7500 series routers and in Cisco 7000 series routers with the 7000 Series Route Switch Processor (RSP7000) and 7000 Series Chassis Interface (RSP7000CI).

The PA-2JT2 port adapter provides two data terminal equipment (DTE) interfaces with coaxial BNC connectors—one for transmit (TX) and one for receive (RX). This port adapter is compatible with G.703a allowing communication over a high-speed digital 6.3-MHz (HSD 6.3) leased line service specified in ITU Recommendation G.704. The PA-2JT2 port adapter provides the following features and capabilities:

- Uses bipolar with 8-zero substitution (B8ZS) encoding.
- Supports CRC-16 and CRC-32.
- Operates at 6.312 Mbps, with 50-percent pulse-width B8ZS encoding.
- Provides a fixed clock rate on each JT2 interface port of 6.144 Mbps (not configurable).
- Provides the functions needed to frame a wideband payload to ITU G.704 and the Nippon Telegram and Telephone Corporation (NTT)-specified 6.144-Mbps frame format.
- Designed to conform with the following emissions standards: FCC Class Limits (FCC 47 CFR Part 15, Subpart B), and EN55022 Class Limits.
- Designed to conform with the following safety standards: UL 1950 D3 Dev., CSA 22.2 No. 950, and TUV-IEC 950.

To configure a PA-2JT2 port adapter refer to the "Specify a Synchronous Serial Interface" in this section.

Configure PPP

To configure PPP, see the "Configuring Media-Independent PPP and Multilink PPP" chapter in the *Dial Solutions Configuration Guide*.

Configure Half-Duplex and Bisync for Synchronous Serial Port Adapters on Cisco 7200 Series Routers

The synchronous serial port adapters (PA-8T-V35, PA-8T-X21, PA-8T-232, and PA-4T+) on Cisco 7200 series routers support half-duplex and binary synchronous communications (Bisync). Bisync is a character-oriented data-link layer protocol for half-duplex applications. In half-duplex mode, data is sent one direction at a time. Direction is controlled by handshaking the RST and CTS control lines. These are described in the following sections:

- Configure Bisync
- Configure Half-Duplex Carrier Modes and Timers

For more information about the PA-8T-V35, PA-8T-X21, PA-8T-232, and PA-4T+ synchronous serial port adapters, refer to the following publications:

- *PA-8T-V35 Synchronous Serial Port Adapter Installation and Configuration*
- *PA-8T-X21 Synchronous Serial Port Adapter Installation and Configuration*
- *PA-8T-232 Synchronous Serial Port Adapter Installation and Configuration*
- *PA-4T+ Synchronous Serial Port Adapter Installation and Configuration*

Configure Bisync

To configure the Bisync feature on the synchronous serial port adapters (PA-8T-V35, PA-8T-X21, PA-8T-232, and PA-4T+) on Cisco 7200 series routers, refer to the "Block Serial Tunnelling (BSTUN)" section of the "Configuring Serial Tunnel and Block Serial Tunnel" chapter of the *Bridging and IBM Networking Configuration Guide*. All commands listed in the "Block Serial Tunnelling (BSTUN)" section apply to the synchronous serial port adapters on Cisco 7200 series routers. Any command syntax that specifies an interface *number* supports the Cisco 7200 series *slot*/*port* syntax.

Configure Half-Duplex Carrier Modes and Timers

This section describes how to configure the synchronous serial port adapters (PA-8T-V35, PA-8T-X21, PA-8T-232, and PA-4T+) on Cisco 7200 series routers. To configure the half-duplex feature on synchronous serial port adapters, perform the tasks described in the following sections, which appear later in this chapter:

- Understand Half-Duplex DTE and DCE State Machines
- Change between Controlled-Carrier and Constant-Carrier Modes Examples
- Tune Half-Duplex Timers

Configure Compression Service Adapters on Cisco 7500 Series Routers

The SA-Comp/1 and SA-Comp/4 data compression service adapters (CSAs) are available on Cisco 7200 series routers and on second-generation Versatile Interface Processors (VIP2s) in Cisco 7500 series routers. (CSAs require VIP2 model VIP2-40.)

The SA-Comp/1 supports up to 64 WAN interfaces, and the SA-Comp/4 supports up to 256 WAN interfaces.

On the Cisco 7200 series routers you can optionally specify which CSA the interface uses to perform hardware compression.

You can configure point-to-point compression on serial interfaces that use PPP encapsulation. Compression reduces the size of a PPP frame via lossless data compression. PPP encapsulations support both predictor and Stacker compression algorithms.

Note If the majority of your traffic is already compressed files, do not use compression.

When you configure Stacker compression on Cisco 7200 series routers, and on Cisco 7500 series routers, there are three methods of compression: hardware compression, distributed compression, and software compression. Specifying the **compress stac** command with no options causes the router to use the fastest available compression method, as described here:

- If the router contains a compression service adapter (CSA), compression is performed in the CSA hardware (hardware compression).
- If the CSA is not available, compression is performed in the software installed on the VIP2 (distributed compression).
- If the VIP2 is not available, compression is performed in the router's main processor (software compression).

Using hardware compression in the CSA frees the router's main processor for other tasks. You can also configure the router to use the VIP2 to perform compression by using the **distributed** option, or to use the router's main processor by using the **software** option. If the VIP2 is not available, compression is performed in the router's main processor.

When compression is performed in software installed in the router's main processor, it might significantly affect system performance. You should disable compression in the router's main processor if the router CPU load exceeds 40 percent. To display the CPU load, use the **show process cpu** EXEC command.

For instructions on configuring compression over PPP, refer to the "Configuring Media-Independent PPP and Multilink PPP" chapter in the *Dial Solutions Configuration Guide*.

Configure Compression of HDLC Data

You can configure point-to-point software compression on serial interfaces that use HDLC encapsulation. Compression reduces the size of a HDLC frame via lossless data compression. The compression algorithm used is a Stacker (LZS) algorithm.

Compression is performed in software and might significantly affect system performance. We recommend that you disable compression if CPU load exceeds 65 percent. To display the CPU load, use the **show process cpu** EXEC command.

If the majority of your traffic is already compressed files, you should not use compression.

To configure compression over HDLC, use the following commands in interface configuration mode:

Step	Command	Purpose
1	**encapsulation hdlc**	Enable encapsulation of a single protocol on the serial line.
2	**compress stac**	Enable compression.

Configure Real-Time Transport Protocol Header Compression

Real-time Transport Protocol (RTP) is a protocol used for carrying packetized audio and video traffic over an IP network. RTP is described in RFC 1889. RTP is not intended for data traffic, which uses TCP or UDP. RTP provides end-to-end network transport functions intended for applications with real-time requirements, such as audio, video, or simulation data over multicast or unicast network services.

For information and instructions for configuring RTP header compression, refer to the "Configuring IP Multicast Routing" chapter in the *Network Protocol Configuration Guide, Part 1*.

Configure the CRC

The cyclic redundancy check (CRC) on a serial interface defaults to a length of 16 bits. To change the length of the CRC to 32 bits on an FSIP or HIP of the Cisco 7500 series only, use the following command in interface configuration mode:

Command	Purpose
crc *size*	Set the length of the CRC.

Use the NRZI Line-Coding Format

All Fast Serial Interface Processor (FSIP) interface types on the Cisco 7500 series routers and the PA-8T and PA-4T+ synchronous serial port adapters on the Cisco 7000 series routers with RSP7000, Cisco 7200 series routers, and Cisco 7500 series routers support nonreturn-to-zero (NRZ) and nonreturn-to-zero inverted (NRZI) format. This is a line-coding format that is required for serial connections in some environments. NRZ encoding is most common. NRZI encoding is used primarily with EIA/TIA-232 connections in IBM environments.

The default configuration for all serial interfaces is NRZ format. The default is **no nrzi-encoding**.

To enable NRZI format, use one of the following commands in interface configuration mode:

Command	Purpose
nrzi-encoding or **nrzi-encoding** [**mark**] (Cisco 7200 series routers and Cisco 7500 series routers)	Enable NRZI encoding format.

Enable the Internal Clock

When a DTE does not return a transmit clock, use the following interface configuration command on the Cisco 7000 series to enable the internally generated clock on a serial interface:

Command	Purpose
transmit-clock-internal	Enable the internally generated clock on a serial interface.

Invert the Data

If the interface on the PA-8T and PA-4T+ synchronous serial port adapters is used to drive a dedicated T1 line that does not have B8ZS encoding, you must invert the data stream on the connecting CSU/DSU or on the interface. Be careful not to invert data on both the CSU/DSU and the interface because two data inversions will cancel each other out.

If the T1 channel on the CT3IP is using AMI line coding, you must invert the data. For more information, see the **t1 linecode** controller command. For more information on the CT3IP, refer to the "Configure a Channelized T3 Interface Processor" section in this chapter.

To invert the data stream, use the following command in interface configuration mode:

Command	Purpose
invert data	Invert the data on an interface.

Invert the Transmit Clock Signal

Systems that use long cables or cables that are not transmitting the TxC signal (transmit echoed clock line, also known as TXCE or SCTE clock) can experience high error rates when operating at the higher transmission speeds. For example, if the interface on the PA-8T and PA-4T+ synchronous serial port adapters is reporting a high number of error packets, a phase shift might be the problem. Inverting the clock signal can correct this shift. To invert the clock signal, use the following command in interface configuration mode:

Command	Purpose
invert txclock	Invert the clock signal on an interface.
invert rxclock	Inverts the phase of the RX clock on the UIO serial interface, which does not use the T1/E1 interface.

Set Transmit Delay

It is possible to send back-to-back data packets over serial interfaces faster than some hosts can receive them. You can specify a minimum dead time after transmitting a packet to alleviate this condition. This setting is available for serial interfaces on the MCI and SCI interface cards and for the HSSI or MIP. Use one of the following commands, as appropriate for your system, in interface configuration mode:

Command	Purpose
transmitter-delay *microseconds*	Set the transmit delay on the MCI and SCI synchronous serial interfaces.
transmitter-delay *hdlc-flags*	Set the transmit delay on the HSSI or MIP.

Configure DTR Signal Pulsing

You can configure pulsing DTR signals on all serial interfaces. When the serial line protocol goes down (for example, because of loss of synchronization) the interface hardware is reset and the DTR signal is held inactive for at least the specified interval. This function is useful for handling encrypting or other similar devices that use the toggling of the DTR signal to resynchronize. To configure DTR signal pulsing, use the following command in interface configuration mode:

Command	Purpose
pulse-time *seconds*	Configure DTR signal pulsing.

Ignore DCD and Monitor DSR as Line Up/Down Indicator

This task applies to Quad Serial NIM interfaces on the Cisco 4000 series and Hitachi-based serial interfaces on the Cisco 2500 series and Cisco 3000 series.

By default, when the serial interface is operating in DTE mode, it monitors the Data Carrier Detect (DCD) signal as the line up/down indicator. By default, the attached DCE device sends the DCD signal. When the DTE interface detects the DCD signal, it changes the state of the interface to up.

In some configurations, such as an SDLC multidrop environment, the DCE device sends the Data Set Ready (DSR) signal instead of the DCD signal, which prevents the interface from coming up. To tell the interface to monitor the DSR signal instead of the DCD signal as the line up/down indicator, use the following command in interface configuration mode:

Command	Purpose
ignore-dcd	Configure the serial interface to monitor the DSR signal as the line up/down indicator.

Unless you know for certain that you really need this feature, be very careful using this command. It will hide the real status of the interface. The interface could actually be down and you will not know by looking at show displays.

Specify the Serial Network Interface Module Timing

On Cisco 4000 series routers, you can specify the serial Network Interface Module timing signal configuration. When the board is operating as a DCE and the DTE provides terminal timing (SCTE or TT), you can configure the DCE to use SCTE from the DTE. When running the line at high speeds and long distances, this strategy prevents phase shifting of the data with respect to the clock.

To configure the DCE to use SCTE from the DTE, use the following command in interface configuration mode:

Command	Purpose
dce-terminal-timing enable	Configure the DCE to use SCTE from the DTE.

When the board is operating as a DTE, you can invert the TXC clock signal it gets from the DCE that the DTE uses to transmit data. Invert the clock signal if the DCE cannot receive SCTE from the DTE, the data is running at high speeds, and the transmission line is long. Again, this prevents phase shifting of the data with respect to the clock.

To configure the interface so that the router inverts the TXC clock signal, use the following command in interface configuration mode:

Command	Purpose
dte-invert-txc	Specify timing configuration to invert TXC clock signal.

Specify G.703 and E1-G.703/G.704 Interface Options

This section describes the optional tasks for configuring a G.703 serial interface (a serial interface that meets the G.703 electrical and mechanical specifications and operates at E1 data rates). G.703 interfaces are available on port adapters for the Fast Serial Interface Processor (FSIP) on a Cisco 4000 series or Cisco 7500 series router.

The E1-G.703/G.704 serial port adapters (PA-4E1G-120 and PA-4E1G-75) are available on Cisco 7500 series routers, Cisco 7200 series routers, and Cisco 7000 series routers with the 7000 Series Route Switch Processor (RSP7000) and 7000 Series Chassis Interface (RSP7000CI). These port adapters provide up to four E1 synchronous serial interfaces, which are compatible with and specified by G.703/G.704. The PA-4E1G-120 supports balanced operation and the PA-4E1G-75 supports unbalanced operation with 15-pin, D-shell (DB-15) receptacles on the port adapters. Both port adapters operate in full-duplex mode at the E1 speed of 2.048-Mbps.

Configuration tasks are described in these sections:

- Enable Framed Mode
- Enable CRC4 Generation
- Use Time Slot 16 for Data
- Specify a Clock Source

Enable Framed Mode

G.703 interfaces have two modes of operation: framed and unframed. By default, G.703 serial interfaces are configured for unframed mode. To enable framed mode, use the following command in interface configuration mode:

Command	Purpose
timeslot *start-slot* - *stop-slot*	Enable framed mode.

To restore the default, use the **no** form of this command or set the starting time slot to 0.

Enable CRC4 Generation

By default, the G.703 CRC4, which is useful for checking data integrity while operating in framed mode, is not generated. To enable generation of the G.703 CRC4, use the following command in interface configuration mode:

Command	Purpose
crc4	Enable CRC4 generation.

Use Time Slot 16 for Data

By default, time slot 16 is used for signaling. It can also be used for data. To specify the use of time slot 16 for data, use the following command in interface configuration mode:

Command	Purpose
ts16	Specify that time slot 16 is used for data.

Specify a Clock Source

A G.703 interface can clock its transmitted data from either its internal clock or from a clock recovered from the line's receive data stream. By default, the interface uses the line's receive data stream. To control which clock is used, use the following command in interface configuration mode:

Command	Purpose
clock source {**line** | **internal** | **loop-timed**}	Specify the clock used for transmitted data.

Configure a Channelized T3 Interface Processor

The Channelized T3 Interface Processor (CT3IP) is available on Cisco 7500 series routers and Cisco 7000 series routers with the 7000 Series Route Switch Processor (RSP7000) and 7000 Series Chassis Interface (RSP7000CI). The Channelized T3 dual-wide port adapter (PA-CT3/4T1) can be used in Cisco 7200 series routers.

Note Throughout this document are references to the CT3IP. However, the term CT3IP also applies to the PA-CT3/4T1. Wherever you see a description of a feature of the CT3IP, the feature is also available in the PA-CT3/4T1.

The CT3IP is a fixed-configuration interface processor based on the second-generation Versatile Interface Processor (VIP2). The CT3 channelized port adapter (PA-CT3/4T1) is a dual-wide port adapter. The CT3IP or PA-CT3/4T1 has four T1 connections via DB-15 connectors and one DS3 connection via BNC connectors. Each DS3 interface can provide up to 28 T1 channels (a single T3 group). Each channel is presented to the system as a serial interface that can be configured individually. The CT3IP or PA-CT3/4T1 can transmit and receive data bidirectionally at the T1 rate of 1.536 Mbps. The four T1 connections use 100-ohm twisted-pair serial cables to external channel service units (CSUs) or to a MultiChannel Interface Processor (MIP) on the same router or on another router. For wide-area networking, the CT3IP or PA-CT3/4T1 can function as a concentrator for a remote site.

Note The VIP2-50 is the newest and fastest second-generation Versatile Interface Processor (VIP2) available on Cisco 7500 series routers that use the Route Switch Processor (RSP), and on Cisco 7000 series routers with the 7000 Series Route Switch Processor (RSP7000) and 7000 Series Chassis Interface (RSP7000CI). The VIP2-50 provides significantly greater packet and program memory space and increased distributed switching performance.

For more information on the VIP2-50, refer to the *Second-Generation Versatile Interface Processor (VIP2) Installation, Configuration, and Maintenance* publication.

As mentioned above, the CT3IP or PA-CT3/4T1 provides 28 T1 channels for serial transmission of data.   Each T1 channel can be configured to use a portion of the T1 bandwidth or the entire T1 bandwidth for data transmission. Bandwidth for each T1 channel can be configured for *n* x 56 kbps or *n* x 64 kbps (where *n* is 1 to 24). The unused portion of the T1 bandwidth, when not running at full T1 speeds, is filled with idle channel data. The CT3IP or PA-CT3/4T1 does not support the aggregation of multiple T1 channels (called *inverse muxing* or *bonding*) for higher bandwidth data rates.

The first three T1 channels of the CT3IP or PA-CT3/4T1 can be broken out to the three DSUP-15 connectors on the CPT3IP or PA-CT3/4T1 so the T1 can be further demultiplexed by the MIP on the same router or on another router or by other multiplexing equipment. When connecting to the MIP, you configure a channelized T1 as described in the "Configure External T1 Channels" section later in this chapter. This is referred to as an external T1 channel.

The CT3IP supports RFC 1406 and RFC 1407 (CISCO-RFC-1407-CAPABILITY.my). For information about Cisco MIBs, refer to the current Cisco IOS release note for the location of the Management Information Base (MIB) online reference.

For RFC 1406, Cisco supports all tables except the "Frac" table. For RFC 1407, Cisco supports all tables except the "FarEnd" tables.

The CT3IP supports the following WAN protocols:

- Frame Relay
- HDLC
- PPP
- SMDS Data Exchange Interface (DXI)

The CT3IP meets ANSI T1.102-1987 and BELCORE TR-TSY-000499 specifications for T3 and meets ANSI 62411 and BELCORE TR499 specifications for T1. The CT3IP provides internal CSU functionality and includes reporting performance data statistics, transmit and receive statistics, and error statistics. The CT3IP supports RFC 1406 (T1 MIB) and RFC 1407 (T3 MIB).

External T1 channels do not provide CSU functionality and must connect to an external CSU.

The CT3IP supports RFC 1406 (T1 MIB) and RFC 1407 (T3 MIB).

Channelized T3 Configuration Task List

Perform the tasks in the following sections to configure the CT3IP (all tasks are optional except for the second task):

- Configure the T3 Controller
- Configure Each T1 Channel
- Configure External T1 Channels
- Troubleshoot the T3 and T1 Channels
- Loopback T1 Channels
- Loopback T3 Lines
- Monitor and Maintain the CT3IP
- Configure Maintenance Data Link Messages
- Enable Performance Report Monitoring

- Enable BERT Test Pattern
- Enable Remote FDL Loopbacks

After you configure the T1 channels on the CT3IP, you can continue configuring it as you would a normal serial interface. All serial interface commands might not be applicable to the T1 channel. For more information, see the "Configure a Synchronous Serial Interface" section earlier in this chapter.

For CT3IP configuration examples, see the "Channelized T3 Interface Processor Configuration Examples" section, later in this chapter.

Configure the T3 Controller

If you do not modify the configuration of the CT3IP, the configuration defaults shown in Table 5 are used.

Table 5 CT3IP Controller Defaults

Attribute	Default Value
Framing	auto-detect
Cable length	224 feet
Clock source	internal

If you must change any of the default configuration attributes, use the first command in global configuration mode followed by any of the optional commands in controller configuration mode:

Command	Purpose
controller t3 *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
framing {**c-bit** | **m23** | **auto-detect**}	Change the framing format.
cablelength *feet*	Change the cable length (values are 0 to 450 feet).
clock source {**internal** | **line**}	Change the clock source used by the T3 controller.

Note The port adapter and port numbers for the CT3IP are 0.

Note Although you can specify a cable length from 0 to 450 feet, the hardware only recognizes two ranges: 0 to 224 and 225 to 450. For example, entering 150 feet uses the 0 to 224 range. If you later change the cable length to 200 feet, there is no change because 200 is within the 0 to 224 range. However, if you change the cable length to 250, the 225 to 450 range is used. The actual number you enter is stored in the configuration file.

Configure Each T1 Channel

You must configure the timeslots used by each T1 channel on the CT3IP. Optionally, you can specify the speed, framing format, and clock source used by each T1 channel. If you do not specify the speed, framing format, and clock source used by each T1 channel, the configuration defaults shown in Table 6 are used.

Table 6 CT3IP T1 Channel Defaults

Attribute	Default Value
Speed	64 kbps
Framing	esf
Clock source	internal
Linecode	b8zs
T1 yellow alarm	detection and generation

To specify the timeslots used by each T1 channel, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**controller t3** *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
2	**t1** *channel* **timeslot** *range* [**speed** {**56** | **64**}]	Configure the timeslots (values are 1 to 24) for the T1 channel (values are 1 to 28) and optionally specify the speed for each T1 channel.

Note The 56-kbps speed is valid only for T1 channels 21 through 28.

Note T1 channels on the CT3IP are numbered 1 to 28 rather than the more traditional zero-based scheme (0 to 27) used with other Cisco products. This is to ensure consistency with telco numbering schemes for T1 channels within channelized T3 equipment.

If you need to change any of the default configuration attributes, use the first command in global configuration mode, followed by any of the optional commands in controller configuration mode:

Command	Purpose
controller t3 *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
t1 *channel* **framing** {**esf** | **sf**}	Change the framing format used by the T1 channel (values are 1 to 28).
t1 *channel* **clock source** {**internal** | **line**}	Change the clock source used by the T1 channel (values are 1 to 28).
t1 *channel* **linecode** {**ami** | **b8zs**}	Change the line coding used by the T1 channel (values are 1 to 28).
no t1 *channel* **yellow** {**detection** | **generation**}	Disable detection or generation of a yellow alarm on the T1 channel (values are 1 to 28).

Note If you select **ami** line coding, you must also invert the data on the T1 channel by using the **invert data** interface command. To do so, first use the **interface serial** *slot/port-adapter/port:t1-channel* global configuration command to select the T1 channel and enter interface configuration mode.

Note If you select **sf** framing, you should consider disabling yellow alarm detection because the yellow alarm can be incorrectly detected with **sf** framing.

After you configure the T1 channels on the CT3IP, you can continue configuring it as you would a normal serial interface. All serial interface commands might not be applicable to the T1 channel. For more information, refer to the “Configure a Synchronous Serial Interface” in this chapter.

To enter interface configuration mode and configure the serial interface that corresponds to a T1 channel, use the following command in global configuration mode:

Command	Purpose
interface serial *slot*/*port-adapter*/*port*:*t1-channel*	Define the serial interface for a T1 channel (values are 1 to 28) and enter interface configuration mode.

Note The port adapter and port numbers for the CT3IP are 0.

In addition to the commands in the “Configure a Synchronous Serial Interface” section, the **invert data** interface command can be used to configure the T1 channels on the CT3IP. If the T1 channel on the CT3IP is using AMI line coding, you must invert the data. For information on the **invert data** interface command, refer to “Invert the Data” later in this chapter. For more information, see the **t1 linecode** controller command.

Configure External T1 Channels

The first three T1 channels (1, 2, and 3) of the CT3IP can be broken out to the DSUP-15 connectors so the T1 channel can be further demultiplexed by the MIP on the same router, another router, or other multiplexing equipment.

Note If a T1 channel that was previously configured as a serial interface is broken out to the external T1 port, that interface and its associated configuration remain intact while the channel is broken out to the external T1 port. The serial interface is not usable during the time the T1 channel is broken out to the external T1 port; however, the configuration remains to facilitate the return of the T1 channel to a serial interface with the **no t1 external** command.

To configure a T1 channel as an external port, use the following commands beginning in EXEC mode:

Step	Command	Purpose
1	**show controller t3** *slot*/*port-adapter*/*port*	Determine if the external device connected to the external T1 port is configured and cabled correctly by locating the line `Ext1...` in the display output. If the line status is `OK,` a valid signal is being received and the signal is not an all-ones signal.
2	**configure terminal**	Enter configuration mode.
3	**controller t3** *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
4	**t1 external** *channel* [**cablelength** *feet*] [**linecode** {**ami** | **b8zs**}]	Configure the T1 channel (values are 1, 2, and 3) as an external port and optionally specify the cable length and line code. The default cable length is 133 feet, and the default line code is b8zs.

Note Only T1 channels 1 through 3 can be configured as an external T1.

Note Although you can specify a cable length from 0 to 655 feet, the hardware only recognizes the following ranges: 0 to 133, 134 to 266, 267 to 399, 400 to 533, and 534 to 655. For example, entering 150 feet uses the 134 to 266 range. If you later change the cable length to 200 feet, there is no change because 200 is within the 134 to 266 range. However, if you change the cable length to 399, the 267 to 399 range is used. The actual number you enter is stored in the configuration file.

After you configure the external T1 channel, you can continue configuring it as a channelized T1 from the MIP. All channelized T1 commands might not be applicable to the T1 interface. To define the T1 controller and enter controller configuration mode use the following command in global configuration mode:

Command	Purpose
controller t1 *slot*/*port*	Select the MIP and enter controller configuration mode.

After you configure the channelized T1 on the MIP, you can continue configuring it as you would a normal serial interface. All serial interface commands might not be applicable to the T1 interface. To enter interface configuration mode and configure the serial interface that corresponds to a T1 channel group, use the following command in global configuration mode:

Command	Purpose
interface serial *slot*/*port***:***t1-channel*	Define the serial interface for a T1 channel on the MIP (values are 1 to 28) and enter interface configuration mode.

For more information, refer to the "Configure Each T1 Channel" section and the "Specify a Synchronous Serial Interface" section in this chapter.

For an example of configuring an external T1 channel, see the "Channelized T3 Interface Processor Configuration Examples" section later in this chapter.

Troubleshoot the T3 and T1 Channels

You can use the following methods to troubleshoot the CT3IP using Cisco IOS software:

- Test the T1 by using the **t1 test** controller configuration command and the test port.
- Loop the T1 by using **loopback** interface configuration commands.
- Loop the T3 by using **loopback** controller configuration commands.

Enable Test Port

You can use the T1 test port available on the CT3IP to break out any of the 28 T1 channels for testing (for example, 24-hour BERT testing as is commonly done by telephone companies before a line is brought into service).

The T1 test port is also available as an external port. For more information on configuring an external port, see the previous section, "Configure External T1 Channels."

Note If a T1 channel that was previously configured as a serial interface is broken out to the T1 port test, that interface and its associated configuration remain intact while the channel is broken out to the T1 port test. The serial interface is not usable during the time the T1 channel is broken out to the T1 test port; however, the configuration remains to facilitate the return of the T1 channel to a serial interface with the **no t1 test** command.

To enable a T1 channel as a test port, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**show controller t3** *slot*/*port-adapter*/*port*	Determine if the external device connected to the external T1 port is configured and cabled correctly by locating the line `Ext1...` in the display output. If the line status is `OK,` a valid signal is being received and the signal is not an all-ones signal.
2	**controller t3** *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
3	**t1 test** *channel* [**cablelength** *feet*] [**linecode** {**ami** | **b8zs**}]	Enable the T1 channel (values are 1 to 28) as a test port and optionally specify the cable length and line code. The default cable length is 133 feet, and the default line code is b8zs.

To disable a T1 channel as a test port, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**controller t3** *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
2	**no t1 test** *channel*	Disable the T1 channel (values are 1 to 28) as a test port.

Note Although you can specify a cable length from 0 to 655 feet, the hardware only recognizes the following ranges: 0 to 133, 134 to 266, 267 to 399, 400 to 533, and 534 to 655. For example, entering 150 feet uses the 134 to 266 range. If you later change the cable length to 200 feet, there is no change because 200 is within the 134 to 266 range. However, if you change the cable length to 399, the 267 to 399 range is used. The actual number you enter is stored in the configuration file.

Loopback T1 Channels

You can perform the following types of loopbacks on a T1 channel:

- Local—Loops the router output data back toward the router at the T1 framer and sends an AIS signal out toward the network (see Figure 12).
- Network line—Loops the data back toward the network before the T1 framer and automatically sets a local loopback (see Figure 13).
- Network payload—Loops just the payload data back toward the network at the T1 framer and automatically sets a local loopback (see Figure 14).
- Remote line inband—Sends a repeating 5-bit inband pattern (00001) to the remote end requesting that it enter into a network line loopback (see Figure 15).

To enable loopbacks on a T1 channel, use the first command in global configuration mode, followed by any one of the following commands:

Command	Purpose
interface serial *slot*/*port-adapter*/*port*:*t1-channel*	Select the T1 channel (values are 1 to 28) on the CT3IP and enter interface configuration mode.
loopback local	Enable the local loopback on the T1 channel.
loopback network line	Enable the network line loopback on the T1 channel.
loopback network payload	Enable the network payload loopback on the T1 channel.
loopback remote line inband	Enable the remote line inband loopback on the T1 channel.

Note The port adapter and port numbers for the CT3IP are 0.

Figure 12 shows an example of a local loopback in which the loopback occurs in the T1 framer.

Figure 12 CT3IP Local Loopback

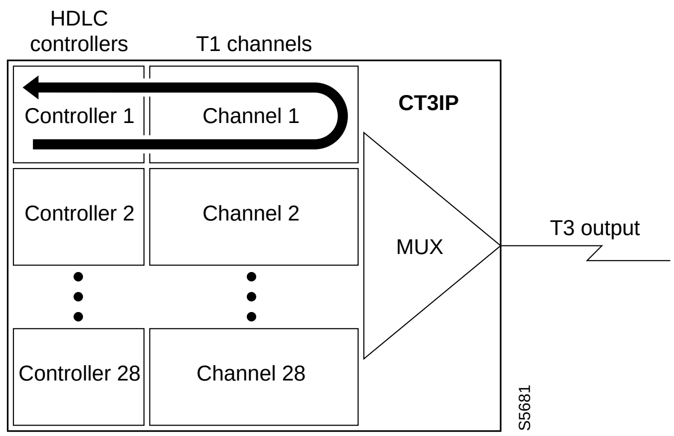


Figure 13 shows an example of a network line loopback in which just the data is looped back toward the network (before the T1 framer).

Figure 13 CT3IP Network Line Loopback

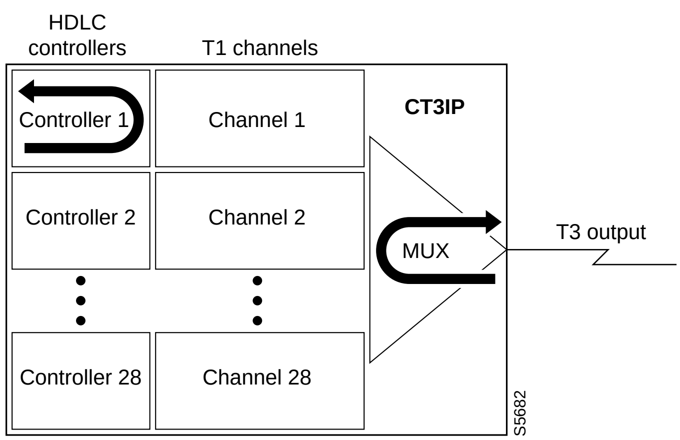


Figure 14 shows an example of a network payload loopback in which just the payload data is looped back toward the network at the T1 framer.

Figure 14 CT3IP Network Payload Loopback

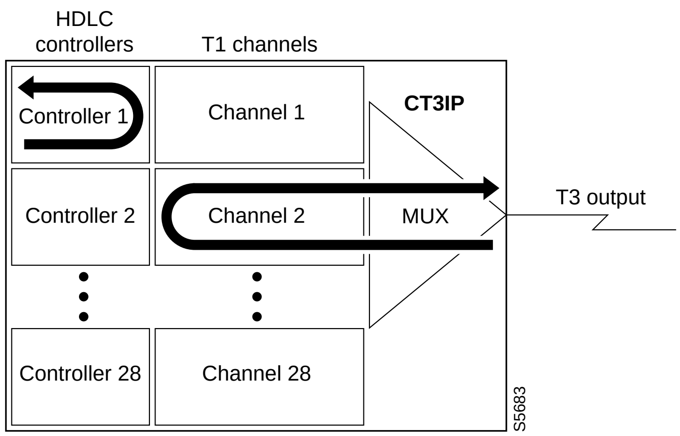
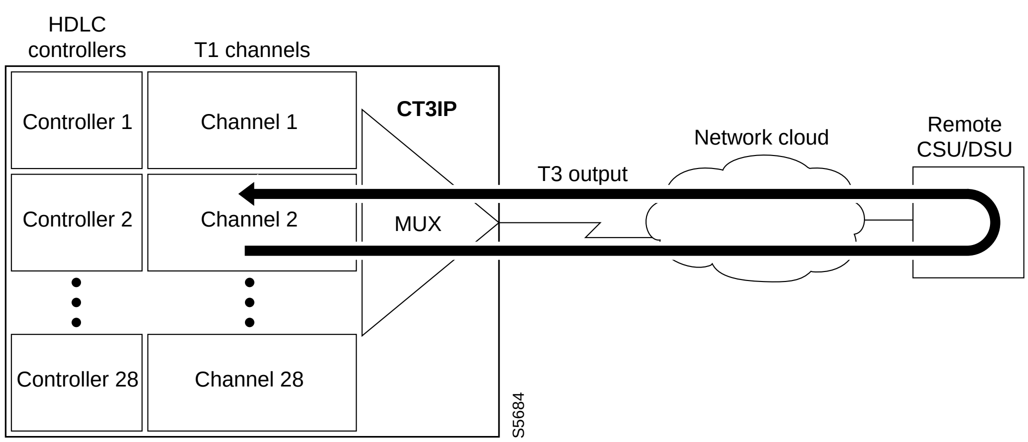


Figure 15 shows an example of a remote inband loopback in which the network line enters a line loopback.

Figure 15 CT3IP Remote Loopback



Loopback T3 Lines

You can put the entire T3 line into loopback mode (that is, all T1 channels are looped) by using the following types of loopbacks:

- Local—Loops the router output data back toward the router at the T1 framer and sends an AIS signal out toward the network.
- Network—Loops the data back toward the network (before the T1 framer).
- Remote —Sends a FEAC (far-end alarm control) request to the remote end requesting that it enter into a network line loopback. FEAC requests (and therefore remote loopbacks) are only possible when the T3 is configured for C-bit framing. The type of framing used is determined by the equipment you are connecting to. (For more information, see the **framing** controller command.)

To enable loopbacks on the T3 (and all T1 channels), use the first command in global configuration mode followed by any one of the following commands:

Command	Purpose
controller t3 *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
loopback local	Enable the local loopback.
loopback network	Enable the network loopback.
loopback remote	Enable the remote loopback.

Note The port adapter and port numbers for the CT3IP are 0.

Monitor and Maintain the CT3IP

After configuring the new interface, you can monitor the status and maintain the CT3IP in the Cisco 7000 series routers with an RSP7000 or in the Cisco 7500 series routers by using the **show** commands. To display the status of any interface, use one of the following commands in EXEC mode:

Command	Purpose
show controller cbus	Display the internal status of each interface processor and list each interface.
show controller t3 [*slot*/*port-adapter*/*port*[**:***t1-channel*]] [**brief** | **tabular**]	Display the status of the T3 and T1 channels (values are 1 to 28) including the T3 alarms and T1 alarms for all 28 T1 channels or only the T1 channel specified.
show interfaces serial *slot*/*port-adapter*/*port***:***t1-channel* [**accounting** | **crb**]	Display statistics about the serial interface for the specified T1 channel (values are 1 to 28) on the router.

Configure Maintenance Data Link Messages

The CT3IP can be configured to send a Maintenance Data Link (MDL) message as defined in the ANSI T1.107a-1990 specification. To specify the transmission of the MDL messages, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**controller t3** *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
2	**mdl** {**transmit** {**path** | **idle-signal** | **test-signal**} | **string** {**eic** | **lic** | **fic** | **unit** | **pfi** | **port** | **generator**} *string*}	Configure the Maintenance Data Link (MDL) message.

Note Specify one **mdl** command for each message. For example, use **mdl string eic Router A** to transmit "Router A" as the equipment identification code and use **mdl string lic Test Network** to transmit "Test Network" as the location identification code.

Use the **show controllers t3** command to display MDL information (received strings). MDL information is displayed only when framing is set to C-bit.

Enable Performance Report Monitoring

The CT3IP supports performance reports via the Facility Data Link (FDL) per ANSI T1.403. By default, performance reports are disabled. To enable FDL performance reports, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**controller t3** *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
2	**t1** *channel* **fdl ansi**	Enable one-second transmission of the performance report for a specific T1 channel (values are 1 to 28).

Note Performance reporting is available only on T1 channels configured for ESF framing.

To display the remote performance report information, use the following command in EXEC command mode:

Command	Purpose
show controller t3 [*slot*/*port-adapter*/*port*[**:***t1-channel*]] **remote performance** [**brief** | **tabular**]	Display the remote performance report information for the T1 channel (values are 1 to 28).

Enable BERT Test Pattern

To enable and disable generation of a bit error rate testing (BERT) test pattern for a specified interval for a specific T1 channel, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**controller t3** *slot*/*port-adapter*/*port*	Select the CT3IP and enter controller configuration mode.
2	**t1** *channel* **bert pattern** {**0s** | **1s** | **2^15** | **2^20** | **2^23**} **interval** *minutes*	Enable a BERT test pattern on a T1 channel (values are 1 to 28).
3	**no t1** *channel* **bert pattern** {**0s** | **1s** | **2^15** | **2^20** | **2^23**} **interval** *minutes*	Disable a BERT test pattern on a T1 channel (values are 1 to 28).

The BERT test patterns from the CT3IP are framed test patterns (that is, the test patterns are inserted into the payload of the framed T1 signal).

To view the BERT results, use the **show controller t3** or **show controller t3 brief** EXEC command. The BERT results include the following information:

- Type of test pattern selected
- Status of the test
- Interval selected
- Time remaining on the BERT test

- Total bit errors
- Total bits received

When the T1 channel has a BERT test running, the line state is DOWN. Also, when the BERT test is running and the Status field is Not Sync, the information in the total bit errors field is not valid. When the BERT test is done, the Status field is not relevant.

The **t1 bert pattern** command is not written to NVRAM because it is only used for testing the T1 channel for a short predefined interval and to avoid accidentally saving the command, which could cause the interface not to come up the next time the router reboots.

Enable Remote FDL Loopbacks

You can perform the following types of remote Facility Data Link (FDL) loopbacks on a T1 channel:

- Remote payload FDL ANSI—Sends a repeating, 16-bit ESF data link code word (00010100 11111111) to the remote end requesting that it enter into a network payload loopback.
- Remote line FDL ANSI—Sends a repeating, 16-bit ESF data link code word (00001110 11111111) to the remote CSU end requesting that it enter into a network line loopback.
- Remote line FDL Bellcore—Sends a repeating, 16-bit ESF data link code word (00010010 11111111) to the remote SmartJack end requesting that it enter into a network line loopback.

To enable loopbacks on a T1 channel, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**interface serial** *slot/port-adapter/port*:*t1-channel* (Cisco 7500 series and Cisco 7000 series routers with the RSP7000 and RSP7000CI) or **interface serial** *slot/port*:*t1-channel* (Cisco 7200 series)	Select the T1 channel (values are 1 to 28) on the CT3IP and enter interface configuration mode.
2	**loopback remote payload** [**fdl**] [**ansi**]	Enable the remote payload FDL ANSI bit loopback on the T1 channel.
3	**loopback remote line fdl** {**ansi** | **bellcore**}	Enable the remote line FDL ANSI bit loopback or remote SmartJack loopback on the T1 channel.

Note The port adapter and port numbers for the CT3IP are 0.

Configure PA-E3 and PA-2E3 Serial Port Adapters

The PA-E3 and PA-2E3 serial port adapters are available on Cisco 7200 series routers, on Cisco 7500 series routers, and on Cisco 7000 series routers with the 7000 Series Route Switch Processor (RSP7000) and 7000 Series Chassis Interface (RSP7000CI). These port adapters provide one (PA-E3) or two (PA-2E3) high-speed, full-duplex, synchronous serial E3 interfaces and integrated data service unit (DSU) functionality.

The E3 port adapters can transmit and receive data at E3 rates of up to 34 Mbps and use a 75-ohm coaxial cable available from Cisco to connect to a serial E3 network. These port adapters support the following:

- 16- and 32-bit cyclic redundancy checks (CRC)
- High-speed HDLC data
- G.751 framing or bypass
- HDB3 line coding
- ATM-DXI, Frame Relay, HDLC, PPP, and SMDS serial encapsulation
- National service bits
- E3 MIB (RFC 1407)
- Scrambling and reduced bandwidth
- Remote and local loopbacks

The PA-E3 port adapter supports a subset of RFC 1407 MIB. We support DS3 Near End Group including—DS3/E3 Configuration Table, DS3/E3 Current Table, DS3/E3 Interval Table, and DS3/E3 Total Table. We do not support DS3 Far End Group and DS3/E3 Fractional Group. The PA-E3 port adapter also supports the Card Table in the Cisco Chassis MIB and the MIB-2 for each PA-E3 interface.

Note For additional information on E3 serial port adapter, refer to the *PA-E3 Serial Port Adapter Installation and Configuration* publication.

PA-E3 and PA-2E3 Serial Port Adapter Configuration Task List

Perform the tasks in the following sections to configure the PA-E3. The first task is required; all other tasks are optional:

- Configure the PA-E3 Port Adapter
- Troubleshoot the PA-E3 Port Adapter
- Monitor and Maintain the PA-E3 Port Adapter

For PA-E3 port adapter configuration examples, see the "PA-E3 Serial Port Adapter Configuration Example" section, later in this chapter.

Configure the PA-E3 Port Adapter

The commands listed in Table 7 have been added to support the PA-E3 interface configuration.

If you do not modify the configuration of the PA-E3, the configuration defaults shown in Table 7 are used.

Table 7 PA-E3 Port Adapter Defaults

Command	Default Value
dsu bandwidth	34010 kbps
dsu mode	0
framing	g751

Table 7 PA-E3 Port Adapter Defaults (continued)

Command	Default Value
international bit	0 0
invert data	data is not inverted
national bit	0
scramble	disabled

If you need to change any of the default configuration attributes, use the first command in global configuration mode, followed by any of the optional commands in interface configuration mode:

Command	Purpose
interface serial *slot*/*port-adapter*/*port* (Cisco 7500 series and Cisco 7000 series routers with the RSP7000 and RSP7000CI) or **interface serial** *slot*/*port* (Cisco 7200 series)	Select the PA-E3 interface and enter interface configuration mode.
dsu bandwidth *kbps*	Change the DSU bandwidth.
dsu mode {**0** | **1**}	Change the DSU mode. To connect to another PA-E3 port adapter or a Digital Link DSU, use the default mode (0). To connect to a Kentrox DSU, use mode 1.
framing {**g751** | **bypass**}	Change the framing used by the interface.
international bit {**0** | **1**} {**0** | **1**}	Change the international bit used by the interface.
invert data	Invert the data stream on the interface.
national bit {**0** | **1**}	Change the national bit used by the interface.
scramble	Enable scrambling on the interface.

Troubleshoot the PA-E3 Port Adapter

To set the following loopbacks to troubleshoot the PA-E3 port adapter using Cisco IOS software, use the first command in global configuration mode, followed by any of the other commands, depending on your needs:

Command	Purpose
loopback dte	Loopback after the LIU toward the terminal.
loopback local	Loopback after going through the framer toward the terminal.
loopback network line	Loopback toward the network before going through the framer.
loopback network payload	Loopback toward the network after going through the framer.

These loopback commands loop all packets from the E3 interface back to the interface and also direct the packets to the network.

Monitor and Maintain the PA-E3 Port Adapter

After configuring the new interface, you can display its status. To show current status of the E3 interface on the PA-E3 port adapter, use any of the following commands in EXEC mode:

Command	Purpose
show interfaces serial *slot*/*port-adapter*/*port* (Cisco 7500 series and Cisco 7000 series routers with the RSP7000 and RSP7000CI) or **show interfaces serial** *slot/port* (Cisco 7200 series)	Display statistics for the E3 interface.
show controllers serial *slot*/*port-adapter*/*port* (Cisco 7500 series and Cisco 7000 series routers with the RSP7000 and RSP7000CI) or **show controllers serial** *slot/port* (Cisco 7200 series)	Display the configuration information for the E3 interface.

Configure PA-T3 and PA-2T3 Serial Port Adapters

The PA-T3 and PA-2T3 serial port adapters are available on Cisco 7200 series routers, on second-generation Versatile Interface Processor (VIP2) in all Cisco 7500 series routers, and on Cisco 7000 series routers with the 7000 Series Route Switch Processor (RSP7000) and 7000 Series Chassis Interface (RSP7000CI). These port adapters provide one (PA-T3) or two (PA-2T3) high-speed, full-duplex, synchronous serial T3 interfaces and integrated data service unit (DSU) functionality.

The T3 port adapters can transmit and receive data at T3 rates of up to 45 Mbps and use a 75-ohm coaxial cable available from Cisco to connect to a serial T3 network. These port adapters support the following features:

- 16- and 32-bit cyclic redundancy checks (CRC)
- High-speed HDLC data
- C-bit, M13, and bypass framing
- HDB3 line coding
- ATM-DXI, Frame Relay, HDLC, PPP, and SMDS serial encapsulation
- DS3 MIB (RFC 1407)
- Scrambling and reduced bandwidth
- Remote and local loopbacks

Note For additional information on interoperability guidelines for T3 serial port adapter DSUs, refer to the *PA-T3 Serial Port Adapter Installation and Configuration* publication.

PA-T3 and PA-2T3 Configuration Task List

Perform the tasks in the following sections to configure the PA-T3 (The first task is required; all other tasks are optional.):

- Configure the PA-T3 Port Adapter
- Troubleshoot the PA-T3 Port Adapter
- Monitor and Maintain the PA-T3 Port Adapter

For PA-T3 port adapter configuration examples, see the "PA-T3 and PA-2T3 Configuration Example" section, later in this chapter.

Configure the PA-T3 Port Adapter

The commands listed in Table 8 have been added to support the PA-T3 interface configuration. If you do not modify the configuration of the PA-T3, the configuration defaults shown in Table 8 are used.

Table 8 PA-T3 Port Adapter Defaults

Command	Default Value
cablelength	50
clock source	line
crc 32	16-bit
dsu bandwidth	44736 kbps
dsu mode	0
framing	C-bit
invert data	data is not inverted
scramble	disabled

If you need to change any of the default configuration attributes, use the first command in global configuration mode, followed by any of the optional commands in interface configuration mode:

Command	Purpose
interface serial *slot*/*port-adapter*/*port* (Cisco 7500 series and Cisco 7000 series routers with the RSP7000 and RSP7000CI) or **interface serial** *slot*/*port* (Cisco 7200 series)	Select the PA-T3 interface and enter interface configuration mode.
cablelength *length*	Change the cable length.
crc 32	Enable 32-bit CRC.
dsu bandwidth *kbps*	Change the DSU bandwidth.
dsu mode {**0** | **1** | **2**}	Change the DSU mode. To connect to another PA-T3 port adapter or a Digital Link DSU, use the default mode (0). To connect to a Kentrox DSU, use mode 1. To connect to a Larscom DSU, use mode 2.
framing {**c-bit** | **m13** | **bypass**}	Change the framing used by the interface.

Command	Purpose
invert data	Invert the data stream on the interface.
scramble	Enable scrambling on the interface.

Troubleshoot the PA-T3 Port Adapter

To set the following loopbacks to troubleshoot the PA-T3 port adapter using Cisco IOS software, use the first command in global configuration mode, followed by any of the other commands depending on your needs:

Command	Purpose
loopback dte	Loopback after the LIU toward the terminal.
loopback local	Loopback after going through the framer toward the terminal.
loopback network line	Loopback toward the network before going through the framer.
loopback network payload	Loopback toward the network after going through the framer.
loopback remote	Send a FEAC to set the remote framer in loopback.

These loopback commands loop all packets from the T3 interface either back to the interface or direct packets from the network back out toward the network.

Monitor and Maintain the PA-T3 Port Adapter

After configuring the new interface, you can display its status. To show current status of the T3 interface on the PA-T3 port adapter, use any of the following commands in EXEC mode:

Command	Purpose
show version	Display system hardware configuration.
show controllers cbus	Display current interface processors and their interfaces.
show interfaces *slot*/*port-adapter*/*port* (Cisco 7500 series and Cisco 7000 series routers with the RSP7000 and RSP7000CI) **show interfaces** *slot/port* (Cisco 7200 series)	Display statistics for the T3 interface.
show controllers serial *slot*/*port-adapter*/*port* (Cisco 7500 series and Cisco 7000 series routers with the RSP7000 and RSP7000CI) **show controllers serial** *slot/port* (Cisco 7200 series)	Display the configuration information for the T3 interface.
show protocols	Display protocols configured for the system and specific interfaces.
more system:running-config	Display running configuration file.
more nvram:startup-config	Display configuration stored in NVRAM.
show diag *slot*	Display specific port adapter information

Configure a Packet OC-3 Interface

The Cisco Packet OC-3 Interface Processor (POSIP) and Packet OC-3 Port Adapter (POSPA) are available on Cisco 7200 and Cisco 7500 series routers.

The POS is a fixed-configuration interface processor that uses second-generation Versatile Interface Processor (VIP2) technology. The POS provides a single 155.520-Mbps, OC-3 physical layer interface for packet-based traffic. This OC-3 interface is fully compatible with SONET and Synchronous Digital Hierarchy (SDH) network facilities and is compliant with RFC 1619, “PPP over SONET/SDH,” and RFC 1662, “PPP in HDLC-like Framing.” The Packet-Over-SONET specification is primarily concerned with the use of the PPP encapsulation over SONET/SDH links.

Table 9 describes the default values set in the initial configuration of a Packet OC-3 interface.

Table 9 Packet OC-3 Interface Default Configuration

Attributes	Default Value
Maximum transmission unit (MTU)	4470 bytes
Framing	SONET STS-3c framing
Loopback internal	No internal loopback
Loopback line	No line loopback
Transmit clocking	Recovered receive clock
Enabling	Shut down

Because the Packet OC-3 interface is partially configured, you might not need to change its configuration before enabling it. However, when the router is powered up, a new Packet OC-3 interface is shut down. To enable the Packet OC-3 interface, you must use the **no shutdown** command in the global configuration mode.

Packet OC-3 Interface Configuration Task List

The values of all Packet OC-3 configuration parameters can be changed to match your network environment. Perform the optional tasks in the following sections if you need to customize the POS configuration:

- Select a Packet OC-3 Interface
- Set the MTU Size
- Configure Framing
- Configure an Interface for Internal Loopback
- Configure an Interface for Line Loopback
- Set the Source of the Transmit Clock
- Enable Payload Scrambling
- Configure an Alarm Indication Signal

Select a Packet OC-3 Interface

The Packet OC-3 interface is referred to as *pos* in the configuration commands. An interface is created for each POS found in the system at reset time.

If you need to change any of the default configuration attributes or otherwise reconfigure the Packet OC-3 interface, use one the following commands in global configuration mode:

Command	Purpose
interface pos *slot*/*port* (Cisco 7200) or **interface pos** *port-adapter* (Cisco 7500)	Select the Packet OC-3 interface and enter interface configuration mode.

Set the MTU Size

To set the maximum transmission unit (MTU) size for the interface, use the following command in interface configuration mode:

Command	Purpose
mtu *bytes*	Set the MTU size.

The value of the *bytes* argument is in the range 64 to 4470 bytes; the default is 4470 bytes. (4470 bytes exactly matches FDDI and HSSI interfaces for autonomous switching.) The **no** form of the command restores the default.

Caution Changing an MTU size on a Cisco 7500 series router will result in recarving of buffers and resetting of all interfaces. The following message is displayed:

```
%RSP-3-Restart:cbus complex88
```

Configure Framing

To configure framing on the Packet OC-3 interface, use one of the following commands in interface configuration mode:

Command	Purpose
pos framing-sdh	Select SDH STM-1 framing.
no pos framing-sdh	Revert to the default SONET STS-3c framing.

Configure an Interface for Internal Loopback

With the **loopback internal** command, packets from the router are looped back in the framer. Outgoing data gets looped back to the receiver without actually being transmitted. With the **loopback line** command, the receive (RX) fiber is logically connected to the transmit fiber (TX) so that packets from the remote router are looped back to it. Incoming data gets looped around and retransmitted without actually being received.

To enable or disable internal loopback on the interface, use one of the following commands in interface configuration mode:

Command	Purpose
loop internal	Enable internal loopback.
no loop internal	Disable internal loopback.

Local loopback is useful for checking that the POS is working. Packets from the router are looped back in the framer.

Configure an Interface for Line Loopback

Line loopback is used primarily for debugging purposes.

To enable or disable an interface for line loopback, use one of the following commands in interface configuration mode:

Command	Purpose
loop line	Enable line loopback.
no loop line	Disable line loopback.

The receive fiber (RX) is logically connected to the transmit fiber (TX) so that packets from the remote router are looped back to it.

Set the Source of the Transmit Clock

By default, the Packet OC-3 interface uses the recovered receive clock to provide transmit clocking. To change the transmit clock source, use one of the following commands in interface configuration mode:

Command	Purpose
clock source	Set the internal clock as the transmit clock source.
no clock source	Set the recovered receive clock to provide transmit clocking.

Enable Payload Scrambling

SONET payload scrambling applies a self-synchronous scrambler (x^43+1) to the Synchronous Payload Envelope (SPE) of the interface to ensure sufficient bit transition density. Both ends of the connection must use the same scrambling algorithm. When enabling POS scrambling on a VIP2 POS on the Cisco 7500 series that has a hardware revision of 1.5 or higher, you can specify CRC 16 only (that is, CRC 32 is currently not supported).

To enable SONET payload scrambling on a POS interface, use the following command in interface configuration mode.

Command	Purpose
pos scramble-atm	Enable SONET payload scrambling.

Configure an Alarm Indication Signal

To configure line alarm indication signals (LAIS) when the POS interface is placed in any administrative shut down state, use the following command in interface configuration mode:

Command	Purpose
pos ais-shut	Send line alarm indication signals.

Configure Automatic Protection Switching of Packet-over-SONET Circuits

The automatic protection switching (APS) feature is supported on Cisco 7500 series routers. This feature allows switchover of packet-over-SONET (POS) circuits and is often required when connecting SONET equipment to telco equipment. APS refers to the mechanism of bringing a “protect” POS interface into the SONET network as the “working” POS interface on a circuit from the intervening SONET equipment.

The protection mechanism used for this feature is “1+1, Bidirectional, nonrevertive” as described in the Bellcore publication “TR-TSY-000253, SONET Transport Systems; Common Generic Criteria, Section 5.3.” In the 1+1 architecture, there is one working interface (circuit) and one protect interface, and the same payload from the transmitting end is sent to both the receiving ends. The receiving end decides which interface to use. The line overhead (LOH) bytes (K1 and K2) in the SONET frame indicate both status and action.

The protect interface is configured with the IP address of the router that has the working interface. The APS Protect Group Protocol, which runs on top of UDP, provides communication between the process controlling the working interface and the process controlling the protect interface. Using this protocol, POS interfaces can be switched due to a router failure, degradation or loss of channel signal, or manual intervention. In bidirectional mode, the receive and transmit channels are switched as a pair. In unidirectional mode, the transmit and receive channels are switched independently. For example, if the receive channel on the working interface has a loss of channel signal, both the receive and transmit channels are switched.

In addition to the new Cisco IOS commands added for the APS feature, the POS interface configuration commands **pos threshold** and **pos report** have been added to support user configuration of the bit error rate (BER) thresholds and reporting of SONET alarms.

APS Configuration Task List

Two SONET connections are required to support APS. In a telco environment, the SONET circuits must be provisioned as APS. You must also provision the operation (for example, 1+1), mode (for example, bidirectional), and revert options (for example, no revert). If the SONET connections are homed on two separate routers (the normal configuration), an out of band (OOB) communications channel between the two routers needs to be set up for APS communication.

When configuring APS, we recommend you configure the working interface first. Normal operation with 1+1 operation is to configure it as a working interface. Also configure the IP address of the interface being used as the APS OOB communications path.

For more information on POS interfaces, refer to the installation and configuration documentation that accompanies the POS hardware.

Perform the first task in the following section to configure APS and POS (The other tasks are optional.):

- Configure APS Working and Protect Interfaces
- Configure Other APS Options
- Monitor and Maintain APS
- Configure SONET Alarm Reporting
- Configure Protection Switch

Configure APS Working and Protect Interfaces

This section describes how to configure a working and protect interface. The commands listed in this section are required. Configure the working interface before configuring the protect interface to avoid the protect interface from becoming the active circuit and disabling the working circuit when it is finally discovered.

To configure the working interface, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**interface pos** *slot*/*port-adapter*/*port*	Specify the POS interface to be configured as the working interface and enter interface configuration mode.
2	**aps working** *circuit-number*	Configure this interface as a working interface.
3	**end**	Exit configuration mode.
4	**show controller pos** **show interface pos** **show aps**	Verify that the interface is configured correctly.

Note If a router has two or more protect interfaces, the **aps group** command for each interface must precede the corresponding **aps protect** command.

To configure the protect interface, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	**interface pos** *slot*/*port-adapter*/*port*	Specify the POS interface to be configured as the protect interface and enter interface configuration mode.
2	**aps protect** *circuit-number ip-address*	Configure this interface as a protect interface. Specify the IP address of the router that contains the working interface.
3	**end**	Exit configuration mode.
4	**show controller pos** **show interface pos** **show aps**	Verify that the interface is configured correctly.

Configure Other APS Options

To configure the other APS options, use any of the following commands in interface configuration mode. The commands listed in this section are optional.

Command	Purpose
aps authenticate *string*	Enable authentication and specify the string that must be present to accept any packet on the OOB communication channel.
aps force *circuit-number*	Manually switch the specified circuit to a protect interface, unless a request of equal or higher priority is in effect.
aps group *group-number*	Allow more than one protect/working interface group to be supported on a router.
aps lockout *circuit-number*	Prevent a working interface from switching to a protect interface.
aps manual *circuit-number*	Manually switch a circuit to a protect interface, unless a request of equal or higher priority is in effect.
aps revert *minutes*	Enable automatic switchover from the protect interface to the working interface after the working interface becomes available.
aps timers *seconds1 seconds2*	Change the time between hello packets and the time before the protect interface process declares a working interface's router to be down (that is, seconds1 for the hello time, and seconds2 for the hold time).
aps unidirectional	Configure a protect interface for unidirectional mode.

Monitor and Maintain APS

To provide information about system processes, the Cisco IOS software includes an extensive list of EXEC commands that begin with the word **show**, which, when executed, display detailed tables of system information. Following is a list of some of the common **show** commands for the APS feature.

Use these commands in privileged EXEC mode to display the information described:

Command	Purpose
show aps	Display information about the automatic protection switching feature.
show controllers pos	Display information about the hardware.
show interface pos	Display information about the interface.

Configure SONET Alarm Reporting

To configure the thresholds and the type of SONET alarms that are reported, use any of the following commands in interface configuration mode. The commands listed in this section are optional. The default settings are adequate for most POS installations.

Command	Purpose
pos threshold {**b1-tca** | **b2-tca** | **b3-tca** | **sd-ber** | **sf-ber**} *rate*	Configure the BER threshold values for signal failure (SF), signal degrade (SD), or threshold crossing alarms alarms (TCA).
pos report {**b1-tca** | **b2-tca** | **b3-tca** | **lais** | **lrdi** | **pais** | **plop** | **prdi** | **rdool** | **sd-ber** | **sf-ber** | **slof** | **slos**}	Enable reporting of selected SONET alarms.

To display the current BER threshold setting or to view the reporting of the SONET alarms, use the **show controllers pos** EXEC command.

Configure Protection Switch

Line alarm indication signal (LAIS) can be used to force a protection switch in an APS environment. To force an APS switch when the interface is placed in administrative shut down state, use the following command in interface configuration mode:

Command	Purpose
pos ais-shut	Send line alarm indication signals.

Configure Serial Interfaces for CSU/DSU Service Modules

The Cisco T1 data service unit/channel service unit (DSU/CSU) WAN interface card is an integrated, managed T1 or fractional T1 WAN interface card. It provides nonchannelized data rates of 1 to 24 X 64 kbps or 1 to 24 X 56 kbps and follows ANSI T1.403 and AT&T Publication 62411 standards.

The Cisco DSU/CSU WAN T1 interface management features include the following:

- You can remotely configure the interface using Telnet and the Cisco IOS command line interface (CLI).
- For monitoring purposes, the router and DSU/CSU are manageable as a single Simple Network Management Protocol (SNMP) entity using CiscoWorks or CiscoView. DSU/CSU statistics are accessed from the CLI.
- The SNMP agent supports the standard Management Information Base II (MIB II), Cisco integrated DSU/CSU MIB, and T1 MIB (RFC 1406).
- Loopbacks (including a manual button for a network line loopback) and bit error rate tester (BERT) tests are provided for troubleshooting.
- Test patterns, alarm counters, and performance reports are accessible using the CLI.
- The module has carrier detect, loopback, and alarm LEDs.

The following CSU and DSU service modules are described in this section:

- Fractional T1/FT/WIC CSU/DSU service module
- 2-Wire and 4-Wire, 56/64-kbps CSU/DSU service module

Fractional T1/FT/WIC CSU/DSU Service Module Configuration Task List

To configure fractional T1 and T1 (FT1/T1) service modules, perform the tasks described in these sections:

- Specify the Clock Source
- Enable Data Inversion before Transmission
- Specify the Frame Type of a FT/T1 Line
- Specify the CSU Line Build Out
- Specify FT1/T1 Line-Code Type
- Enable Remote Alarms
- Enable Loopcodes that Initiate Remote Loopbacks
- Specify Timeslots
- Enable T1 CSU WIC

Specify the Clock Source

To specify the clock source for the FT1/T1 CSU/DSU module, use the following command in interface configuration mode:

Command	Purpose
service-module t1 clock source {**internal** | **line**}	Specify the clock source, for the CSU/DSU internal clock or the line clock.

Enable Data Inversion before Transmission

Data inversion is used to guarantee the ones density requirement on an alternate mark inversion (AMI) line when using bit-oriented protocols such as High-Level Data Link Control (HDLC), Point-to-Point Protocol (PPP), X.25, and Frame Relay.

To guarantee the ones density requirement on an AMI line using the FT1/T1 CSU/DSU module, use the following command in interface configuration mode:

Command	Purpose
service-module t1 data-coding inverted	Invert bit codes by changing all 1 bits to 0 bits and all 0 bits to 1 bits.

If the timeslot speed is set to 56 kbps, this command is rejected because line density is guaranteed when transmitting at 56 kbps. Use this command with the 64-kbps line speed. If you transmit inverted bit codes, both CSU/DSUs must have this command configured for successful communication.

To enable normal data transmission on a FT1/T1 network, use the following command in interface configuration mode:

Command	Purpose
service-module tx1 data-coding normal or **no service-module t1 data-coding inverted**	Enable normal data transmission on a T1 network.

Specify the Frame Type of a FT/T1 Line

To specify the frame type for a line using the FT1/T1 CSU/DSU module, use the following command in interface configuration mode:

Command	Purpose
service-module t1 framing {**sf** | **esf**}	Specify a FT1/T1 frame type. Choose either D4 Super Frame (sf) or Extended Super Frame (esf).

In most cases, the service provider determines which framing type, either **esf** or **sf**, is required for your circuit.

Specify the CSU Line Build Out

To decrease the outgoing signal strength to an optimum value for the telecommunication carrier network, use the following command on the FT1/T1 CSU/DSU module in interface configuration mode:

Command	Purpose
service-module t1 lbo {**-15 db** | **-7.5 db**}	Decrease the outgoing signal strength in decibels.

To transmit packets without decreasing outgoing signal strength, use the following command in interface configuration mode:

Command	Purpose
service-module t1 lbo none	Transmits packets without decreasing outgoing signal strength.

The ideal signal strength should be between –15 dB and –22 dB, which is calculated by adding the phone company loss + cable length loss + line build out.

You may use this command in back-to-back configurations, but it is not needed on most actual T1 lines.

Specify FT1/T1 Line-Code Type

To configure the line code for the FT1/T1 CSU/DSU module, use the following command in interface configuration mode:

Command	Purpose
service-module t1 linecode {**ami** | **b8zs**}	Specify a line-code type. Choose alternate mark inversion (AMI) or binary 8 zero substitution (B8ZS).

Configuring B8ZS is a method of ensuring the ones density requirement on a T1 line by substituting intentional bipolar violations in bit positions four and seven for a sequence of eight zero bits. When the CSU/DSU is configured for AMI, you must guarantee the ones density requirement in your router configuration using the **service-module t1 data-coding inverted** command or the **service-module t1 timeslots speed 56** command.

In most cases, your T1 service provider determines which line-code type, either **ami** or **b8zs**, is required for your T1 circuit.

Enable Remote Alarms

To generate remote alarms (yellow alarms) at the local CSU/DSU or detect remote alarms sent from the remote CSU/DSU, use the following command in interface configuration mode:

Command	Purpose
service-module t1 remote-alarm-enable	Enable remote alarms.

Remote alarms are transmitted by the CSU/DSU when it detects an alarm condition, such as a red alarm (loss of signal) or blue alarm (unframed 1's). The receiving CSU/DSU then knows there is an error condition on the line.

With D4 super frame configured, a remote alarm condition is transmitted by setting the bit 2 of each time slot to zero. For received user data that has the bit 2 of each time slot set to zero, the CSU/DSU interprets the data as a remote alarm and interrupts data transmission, which explains why remote alarms are disabled by default. With Extended Super Frame configured, the remote alarm condition is signalled out of band in the facility data link.

You can see if the FT1/T1 CSU/DSU is receiving a remote alarm (yellow alarm) by issuing the **show service-module** command.

To disable remote alarms, use the following command in interface configuration mode:

Command	Purpose
no service-module t1 remote-alarm-enable	Disable remote alarms.

Enable Loopcodes that Initiate Remote Loopbacks

To specify if the fractional T1/T1 CSU/DSU module goes into loopback when it receives a loopback code on the line, use the following commands in interface configuration mode:

Step	Command	Purpose
1	**service-module t1 remote-loopback full**	Configures the remote loopback code used to transmit or accept CSU loopback requests.
2	**service-module t1 remote-loopback payload** [**alternate** | **v54**]	Configures the loopback code used by the local CSU/DSU to generate or detect payload-loopback commands.

Note By using the **service-module t1 remote-loopback** command without specifying any keywords, you enable the standard-loopup codes, which use a 1-in-5 pattern for loopup and a 1-in-3 pattern for loopdown.

You can simultaneously configure the **full** and **payload** loopback points. However, only one loopback payload code can be configured at a time. For example, if you configure the **service-module t1 remote-loopback payload alternate** command, a payload v.54 request, which is the industry standard and default, cannot be transmitted or accepted. Full and payload loopbacks with standard-loopup codes are enabled by default.

The **no** form of this command disables loopback requests. For example, the **no service-module t1 remote-loopback full** command ignores all full-bandwidth loopback transmissions and requests. Configuring the **no** form of the command may not prevent telco line providers from looping your router in esf mode, because fractional T1/T1 telcos use facilities data-link messages to initiate loopbacks.

If you enable the **service-module t1 remote-loopback** command, the **loopback remote** commands on the FT1/T1 CSU/DSU module will not be successful.

Specify Timeslots

To define timeslots for FT1/T1 module, use the following command in interface configuration mode:

Command	Purpose
service-module t1 timeslots {*range* | **all**} [**speed** {**56** | **64**}]	Specify timeslots.

This command specifies which timeslots are used in fractional T1 operation and determines the amount of bandwidth available to the router in each timeslot. The *range* specifies the DS0 timeslots that constitute the FT1/T1 channel. The range is from 1 to 24, where the first timeslot is numbered 1, and the last timeslot is numbered 24. Specify this field by using a series of subranges separated by commas. The timeslot range must match the timeslots assigned to the channel group. In most cases, the service provider defines the timeslots that comprise a channel group. Use the **no** form of this command to select all FT1/T1 timeslots transmitting at 64 kbps, which is the default.

To use the entire T1 line, enable the **service-module T1 timeslots all** command.

Enable T1 CSU WIC

The following are prerequisites to enable the T1 CSU WIC:

- Leased line from your telephone company
- Configuration parameters depending on your specific telephone company. For most connections, the default settings should suffice:
    - service-module t1 clock source line
    - service-module t1 data-coding normal
    - service-module t1 timeslots all speed 64
    - service-module t1 framing esf
    - service-module t1 lbo none
    - service-module t1 linecode b8zs
    - no service-module t1 remote-alarm-enable
    - no service-module t1 fdl

Note To view the current configuration, use the **show service-module serial** *slot/port* command. For further information about these commands and how to change them, refer to the Cisco IOS configuration guides and command references that shipped with your router.

To configure the router to send SNMP traps, use the following commands:

Step	Command	Purpose
	interface serial *slot/port* (*slot/port* corresponds to where the WIC card is installed in your router)	Enter interface configuration mode.
	service-module t1 fdl {**ansi** | **att**}	Set the **fdl** parameter to either **ansi** or **att**.
	<Ctrl-z>	Exit interface configuration mode.
	more system:running-config	Verify that the **fdl** parameter has been changed.

2-Wire and 4-Wire, 56/64-kbps CSU/DSU Service Module Configuration Task List

To configure 2- and 4-wire, 56/64 kbps service modules, perform the tasks described in these sections:

- Set the Clock Source
- Set the Network Line Speed
- Enable Scrambled Data Coding
- Change between Digital Data Service and Switched Dial-Up Modes
- Enable Acceptance of a Remote Loopback Request
- Select a Service Provider

Set the Clock Source

In most applications, the CSU/DSU should be configured with the **service-module 56k clock source line** command. For back-to-back configurations, use the **internal** keyword to configure one CSU/DSU and use the **line** keyword to configure the other CSU/DSU.

To configure the clock source for a 4-wire, 56/64-kbps CSU/DSU module, use the following command for a serial interface in interface configuration mode:

Command	Purpose
service-module 56k clock source {**line** | **internal**}	Configure the clock source.

Use the **no** form of this command to revert to the default clock source, which is the line clock.

Set the Network Line Speed

To configure the network line speed for a 4-wire, 56/64-kbps CSU/DSU module, use the following command for a serial interface in interface configuration mode:

Command	Purpose
service-module 56k clock rate *speed*	Set the network line speed.

You can use the following line speed settings: 2.4, 4.8, 9.6, 19.2, 38.4, 56, 64 kpbs, and an **auto** setting.

The 64-kbps line speed cannot be used with back-to-back digital data service (DDS) lines. The subrate line speeds are determined by the service provider.

Only the 56-kbps line speed is available in switched mode. Switched mode is the default on the 2-wire CSU/DSU and is enabled by the **service-module 56k network-type** interface configuration command on the 4-wire CSU/DSU.

The **auto** linespeed setting enables the CSU/DSU to decipher current line speed from the sealing current running on the network. Because back-to-back DDS lines do not have sealing current, use the **auto** setting only when transmitting over telco DDS lines and using the line clock as the clock source.

Use the **no** form of this command to enable a network line speed of 56 kbps, which is the default.

Enable Scrambled Data Coding

To prevent application data from replicating loopback codes when operating at 64-kbps on a 4-wire CSU/DSU, use the following command for a serial interface in interface configuration mode:

Command	Purpose
service-module 56k data-coding scrambled	Scramble bit codes before transmission.

Enable the scrambled configuration only in 64-kbps digital data service (DDS) mode. If the network type is set to switched, the configuration is refused.

If you transmit scrambled bit codes, both CSU/DSUs must have this command configured for successful communication.

To enable normal data transmission for the 4-wire, 56/64-kbps module, use one of the following commands for a serial interface in interface configuration mode:

Command	Purpose
service-module 56k data-coding normal or **no service-module 56k data-coding**	Specify normal data transmission.

Change between Digital Data Service and Switched Dial-Up Modes

To transmit packets in Digital Data Service (DDS) mode or switched dial-up mode using the 4-wire, 56/64-kbps CSU/DSU module, use one of the following commands for a serial interface in interface configuration mode:

Command	Purpose
service-module 56k network-type dds or **service-module 56k network-type switched**	Transmit packets in switched dial-up mode or DDS mode.

Use the **no** form of these commands to transmit from a dedicated leased line in DDS mode. DDS is enabled by default for the 4-wire CSU/DSU. Switched is enabled by default for the 2-wire CSU/DSU.

In switched mode, you need additional dialer configuration commands to configure dial-out numbers. Before you enable the **service-module 56k network-type switched** command, both CSU/DSU's must use a clock source coming from the line and the clock rate configured to **auto** or **56k** kbps. If the clock rate is not set correctly, this command will not be accepted.

The 2-wire and 4-wire, 56/64-kbps CSU/DSU modules use V.25 *bis* dial commands to interface with the router. Therefore, the interface must be configured using the **dialer in-band** command. DTR dial is not supported.

Note Any loopbacks in progress are terminated when switching between modes.

Enable Acceptance of a Remote Loopback Request

To enable the acceptance of a remote loopback request on a 2- or 4-wire, 56/64-kbps CSU/DSU module, use the following command for a serial interface in interface configuration mode:

Command	Purpose
service-module 56k remote-loopback	Enable a remote loopback request.

The **no service-module 56k remote-loopback** command prevents the local CSU/DSU from being placed into loopback by remote devices on the line. Unlike the T1 module, the 2- or 4-wire, 56/64-kbps CSU/DSU module can still initiate remote loopbacks with the **no** form of this command configured.

Select a Service Provider

To select a service provider to use with a 2- or 4-wire, 56/64 kbps dial-up line, use the following command for a serial interface in interface configuration mode:

Command	Purpose
service-module 56k switched-carrier {**att** | **other** | **sprint**}	Select a service provider for a 2 or 4 wire switched 56/64 kbps dialup line.

The **att** keyword specifies AT&T or another digital network service provider as the line carrier, which is the default for the 4-wire, 56/64-kbps CSU/DSU module. The **sprint** keyword specifies Sprint or another service provider whose network carries mixed voice and data as the line carrier, which is the default for the 2-wire switched 56-kbps CSU/DSU module.

In a Sprint network, echo-canceler tones are sent during call setup to prevent echo cancelers from damaging digital data. The transmission of these cancelers may increase call setup times by 8 seconds on the 4-wire module. Having echo cancellation enabled does not affect data traffic.

This configuration command is ignored if the network type is DDS.

Use the **no** form of this command to enable the default service provider. AT&T is enabled by default on the 4-wire, 56/64 module. Sprint is enabled by default on the 2-wire switched 56 module.

Configure Low-Speed Serial Interfaces

This section describes how to configure low-speed serial interfaces. In addition to the background information described in the "Understand Half-Duplex DTE and DCE State Machines" section, these configuration guidelines are provided for configuring low-speed serial interfaces:

- Change between Controlled-Carrier and Constant-Carrier Modes
- Tune Half-Duplex Timers
- Change between Synchronous and Asynchronous Modes

For configuration Examples, see the "APS Configuration Examples" section at the end of this chapter.

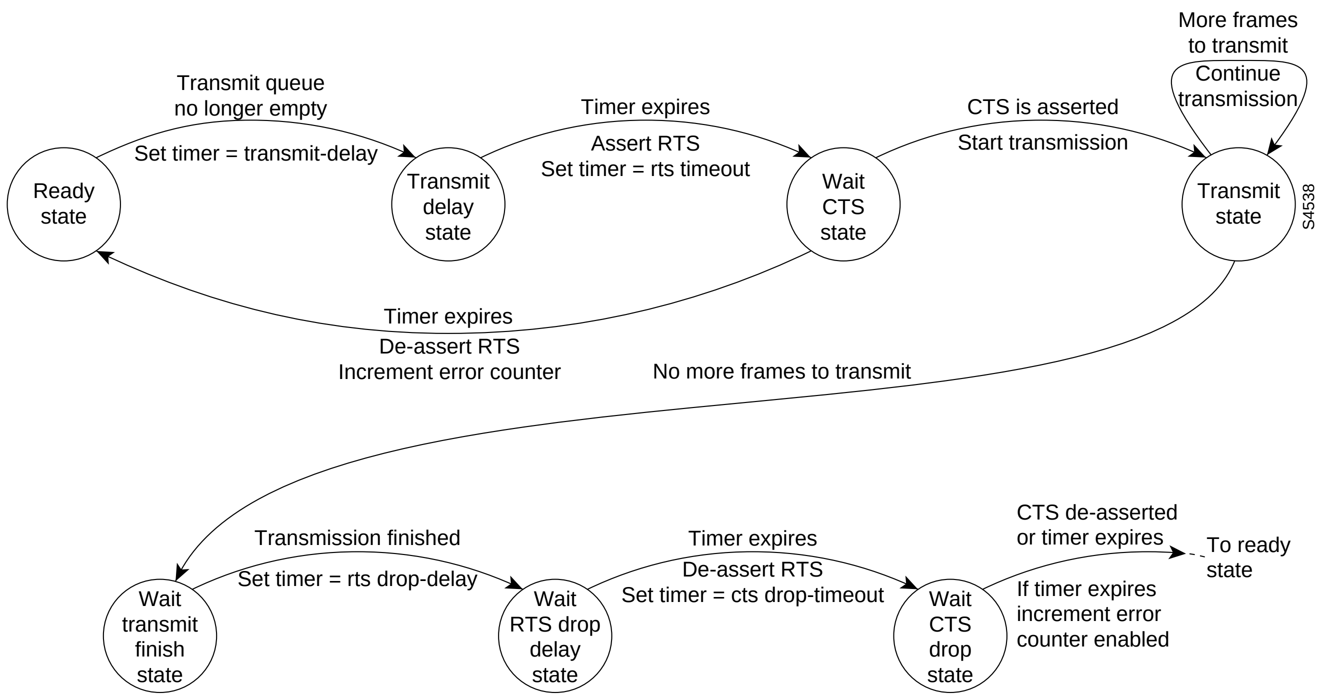
Understand Half-Duplex DTE and DCE State Machines

The following section describes the communication between half-duplex DTE transmit and receive state machines and half-duplex DCE transmit and receive state machines.

Half-Duplex DTE State Machines

As shown in Figure 16, the half-duplex DTE transmit state machine for low-speed interfaces remains in the ready state when it is quiescent. When a frame is available for transmission, the state machine enters the transmit delay state and waits for a time period, which is defined by the **half-duplex timer transmit-delay** command. The default is 0 ms. Transmission delays are used for debugging half-duplex links and assisting lower-speed receivers that cannot process back-to-back frames.

Figure 16 Half-Duplex DTE Transmit State Machine



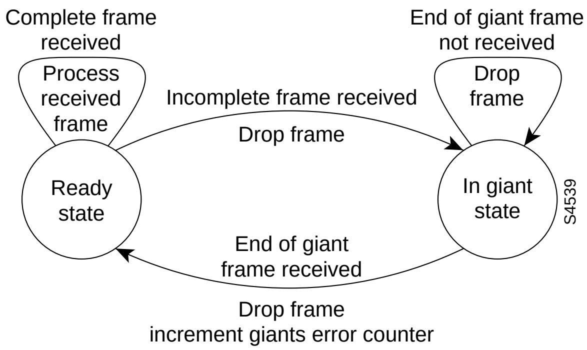
After idling for a defined number of milliseconds, the state machine asserts a request to send (RTS) signal and changes to the wait-clear-to-send (CTS) state for the data communications equipment (DCE) to assert CTS. A timeout timer with a value set by the **half-duplex timer rts-timeout** command starts. This default is 3 ms. If the timeout timer expires before CTS is asserted, the state machine returns to the ready state and deasserts RTS. If CTS is asserted prior to the timer's expiration, the state machine enters the transmit state and sends the frames.

Once there are no more frames to transmit, the state machine transitions to the wait transmit finish state. The machine waits for the transmit first in first out (FIFO) in the serial controller to empty, starts a delay timer with a value defined by the **half-duplex timer rts-drop-delay** interface command, and transitions to the wait RTS drop delay state.

When the timer in the wait RTS drop delay state expires, the state machine deasserts RTS and transitions to the wait CTS drop state. A timeout timer with a value set by the **half-duplex timer cts-drop-timeout** interface command starts, and the state machine waits for the CTS to deassert. The default is 250 ms. Once the CTS signal is deasserted or the timeout timer expires, the state machine transitions back to the ready state. If the timer expires before CTS is deasserted, an error counter is incremented, which can be displayed by issuing the **show controllers** command for the serial interface in question.

As shown in Figure 17, a half-duplex DTE receive state machine for low-speed interfaces idles and receives frames in the ready state. A giant frame is any frame whose size exceeds the maximum transmission unit (MTU). If the beginning of a giant frame is received, the state machine transitions to the in giant state and discards frame fragments until it receives the end of the giant frame. At this point, the state machine transitions back to the ready state and waits for the next frame to arrive.

Figure 17 Half-Duplex DTE Receive State Machine

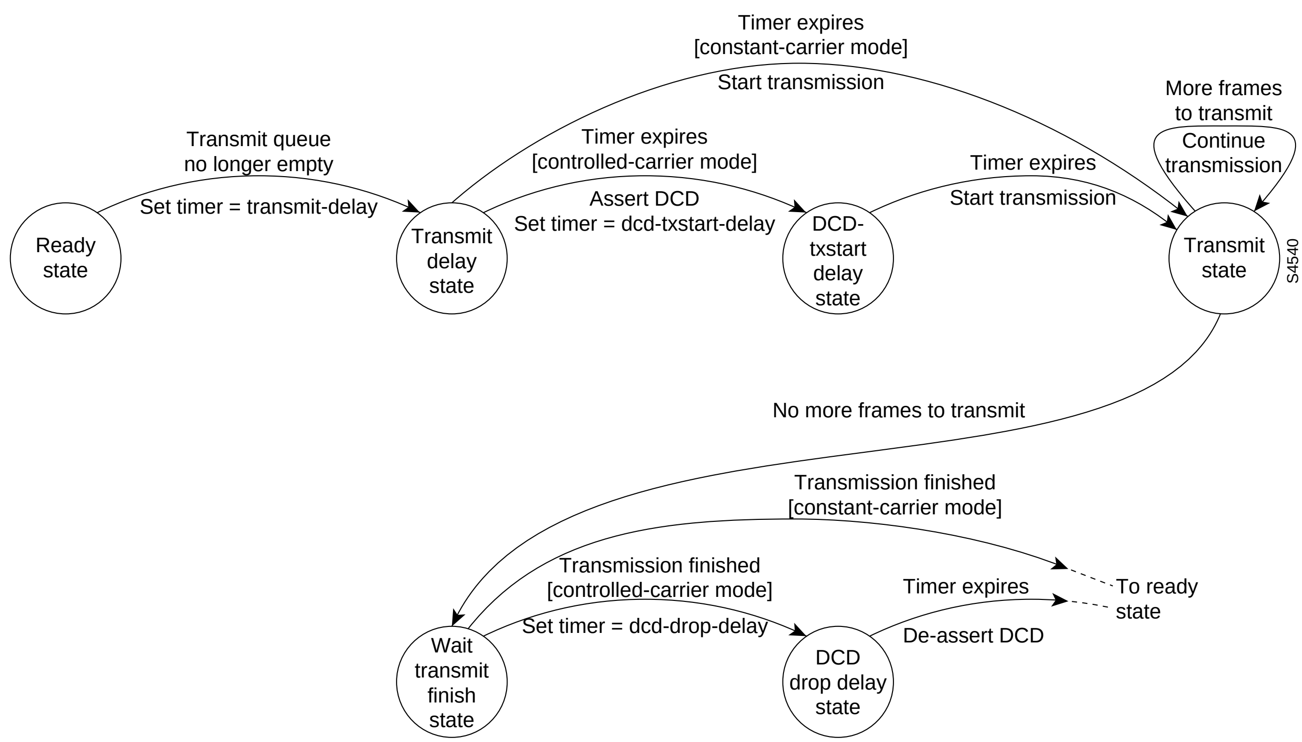


An error counter is incremented upon receipt of the giant frames. To view the error counter, use the **show interface** command for the serial interface in question.

Half-Duplex DCE State Machines

As shown in Figure 18, for a low-speed serial interface in DCE mode, the half-duplex DCE transmit state machine idles in the ready state when it is quiescent. When a frame is available for transmission on the serial interface, such as when the output queues are no longer empty, the state machine starts a timer (based on the value of the **transmit-delay** command, in milliseconds) and transitions to the transmit delay state. Similar to the DTE transmit state machine, the transmit delay state gives you the option of setting a delay between the transmission of frames; for example, this feature lets you compensate for a slow receiver that loses data when multiple frames are received in quick succession. The default **transmit-delay** value is 0 ms; use the **half-duplex timer transmit-delay** interface configuration command to specify a delay value not equal to 0.

Figure 18 Half-Duplex DCE Transmit State Machine



After the transmit delay state, the next state depends on whether the interface is in constant-carrier mode (the default) or controlled-carrier mode.

If the interface is in constant-carrier mode, it passes through the following states:

1. The state machine passes to the transmit state when the **transmit-delay** timer expires. The state machine stays in the transmit state until there are no more frames to transmit.
2. When there are no more frames to transmit, the state machine passes to the wait transmit finish state, where it waits for the transmit FIFO to empty.
3. Once the FIFO empties, the DCE passes back to the ready state and waits for the next frame to appear in the output queue.

If the interface is in controlled-carrier mode, the interface performs a handshake using the data carrier detect (DCD) signal. In this mode, DCD is deasserted when the interface is idle and has nothing to transmit. The transmit state machine transitions through the states as follows:

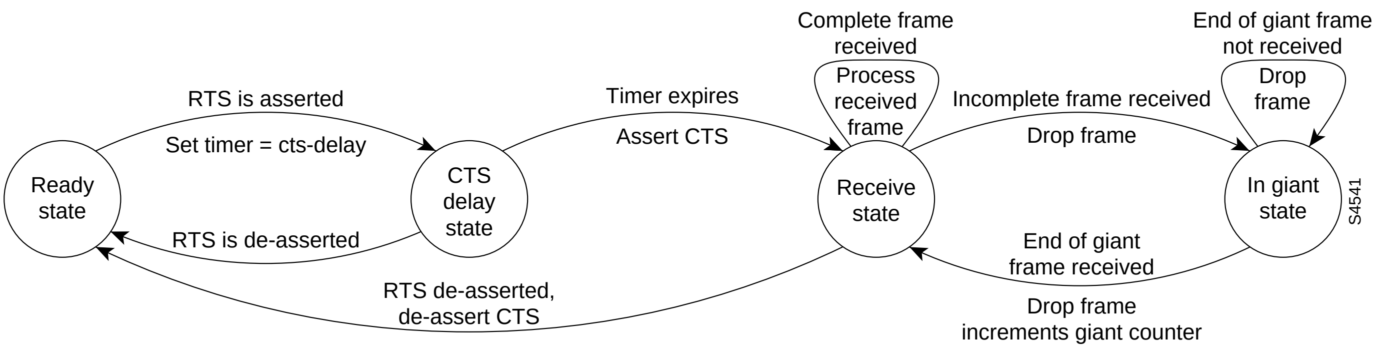
1. After the **transmit-delay** timer expires, the DCE asserts DCD and transitions to the DCD-txstart delay state to ensure a time delay between the assertion of DCD and the start of transmission. A timer with the value **dcd-txstart-delay** is started. (This timer has a default value of 100 ms; use the **half-duplex timer dcd-txstart-delay** interface configuration command to specify a delay value.)
2. When this delay timer expires, the state machine transitions to the transmit state and transmits frames until there are no more frames to transmit.
3. After the DCE transmits the last frame, it transitions to the wait transmit finish state, where it waits for transmit FIFO to empty and the last frame to transmit to the wire. Then DCE starts a delay timer with the value **dcd-drop-delay**. (This timer has the default value of 100 ms; use the **half-duplex timer dcd-drop-delay** interface configuration command to specify a delay value.)

4 The DCE transitions to the wait DCD drop delay state. This state causes a time delay between the transmission of the last frame and the deassertion of DCD in the controlled-carrier mode for DCE transmits.

5 When the timer expires, the DCE deasserts DCD and transitions back to the ready state and stays there until there is a frame to transmit on that interface.

As shown in Figure 19, the half-duplex DCE receive state machine idles in the ready state when it is quiescent. It transitions out of this state when the DTE asserts RTS. In response, the DCE starts a timer with the value **cts-delay**. This timer delays the assertion of CTS because some DTE interfaces expect this delay. (The default value of this timer is 0 ms; use the **half-duplex timer cts-delay** interface configuration command to specify a delay value.)

Figure 19 Half-Duplex DCE Receive State Machine



When the timer expires, the DCE state machine asserts CTS and transitions to the receive state. It stays in the receive state until there is a frame to receive. If the beginning of a giant frame is received, it transitions to the in giant state and keeps discarding all the fragments of the giant frame and transitions back to the receive state.

Transitions back to the ready state occur when RTS is deasserted by the DTE. The response of the DCE to the deassertion of RTS is to deassert CTS and go back to the ready state.

Change between Controlled-Carrier and Constant-Carrier Modes

The **half-duplex controlled-carrier** command enables you to change between controlled-carrier and constant-carrier modes for low-speed serial DCE interfaces in half-duplex mode. Configure a serial interface for half-duplex mode by using the **half-duplex** command. Full-duplex mode is the default for serial interfaces. This interface configuration is available on Cisco 2520 through Cisco 2523 routers.

Controlled-carrier operation means that the DCE interface will have DCD deasserted in the quiescent state. When the interface has something to transmit, it will assert DCD, wait a user-configured amount of time, then start the transmission. When it has finished transmitting, it will again wait a user-configured amount of time, then deassert DCD.

Place a Low-Speed Serial Interface in Controlled-Carrier Mode

To place a low-speed serial interface in controlled-carrier mode, use the following command in interface configuration mode:

Command	Purpose
half-duplex controlled-carrier	Place a low-speed serial interface in controlled-carrier mode.

Place a Low-Speed Serial Interface in Constant-Carrier Mode

To return a low-speed serial interface to constant-carrier mode from controlled-carrier mode, use the following command in interface configuration mode:

Command	Purpose
no half-duplex controlled-carrier	Place a low-speed serial interface in constant-carrier mode.

Tune Half-Duplex Timers

To tune half-duplex timers, use the following command in interface configuration mode:

Command	Purpose
half-duplex timer {**cts-delay** *value* | **cts-drop-timeout** *value* | **dcd-drop-delay** *value* | **dcd-txstart-delay** *value* | **rts-drop-delay** *value* | **rts-timeout** *value* | **transmit-delay** *value*}	Tune half-duplex timers.

The timer tuning commands permit you to adjust the timing of the half-duplex state machines to suit the particular needs of their half-duplex installation.

Note that the **half-duplex timer** command and its options deprecates the following two timer tuning commands that are available only on high-speed serial interfaces:

- **sdlc cts-delay**
- **sdlc rts-timeout**

Change between Synchronous and Asynchronous Modes

To specify the mode of a low-speed serial interface as either synchronous or asynchronous, use the following command in interface configuration mode:

Command	Purpose
physical-layer {**sync** | **async**}	Specify the mode of a low-speed interface as either synchronous or asynchronous.

This command applies only to low-speed serial interfaces available on Cisco 2520 through Cisco 2523 routers.

In synchronous mode, low-speed serial interfaces support all interface configuration commands available for high-speed serial interfaces, except the following two commands:

- **sdlc cts-delay**
- **sdlc rts-timeout**

When placed in asynchronous mode, low-speed serial interfaces support all commands available for standard asynchronous interfaces. The default is synchronous mode.

Note When you use this command, it does not appear in the output of **show running config** and **show startup config** command, because the command is a physical-layer command.

Return a Low-Speed Serial Interface to Synchronous Mode

To return to the default mode (synchronous) of a low-speed serial interface on a Cisco 2520 through Cisco 2523 router, use the following command in interface configuration mode:

Command	Purpose
no physical-layer	Return the interface to its default mode, which is synchronous.

Serial Interface Configuration Examples

This section includes the following example groups:

- Enable Interface Configuration Examples
- HSSI Configuration Examples
- Channelized T3 Interface Processor Configuration Examples
- PA-E3 Serial Port Adapter Configuration Example
- PA-T3 and PA-2T3 Configuration Example
- Packet OC-3 Interface Configuration Examples
- APS Configuration Examples
- CSU/DSU Service Module Examples
- Low-Speed Serial Interface Examples

Enable Interface Configuration Examples

The following example illustrates how to begin interface configuration on a serial interface. It assigns Point-to-Point (PPP) encapsulation to serial interface 0.

```
interface serial 0
 encapsulation ppp
```

The same example on a Cisco 7500 series routers requires the following commands:

```
interface serial 1/0
 encapsulation ppp
```

Configure Specific IP Addresses for an Interface Example

This example shows how to configure the access server so that it will use the default address pool on all interfaces except interface 7, on which it will use an address pool called lass:

```
ip address-pool local
ip local-pool lass 172.30.0.1
 async interface
 interface 7
 peer default ip address lass
```

HSSI Configuration Examples

The following example show a simple configuration for a HSSI port adapter on a Cisco 7500 series router:

```
Router# configure terminal
Router(config)# interface hssi 2/0/0
Router(config-if)# ip address 1.1.1.10 255.255.255.0
Router(config-if)# description To San Jose, circuit ID 1234
Router(config-if)# no ip mroute-cache
Router(config-if)# exit
Router(config)# exit
Router#
```

The following example shows how to configure a 1-port HSSI network module on a Cisco 3600 series router. Both sides of the network connection need to be configured:

```
interface hssi 0/0
 ip address 10.1.1.1 255.255.255.0
 hssi internal-clock
 no fair-queue
 no shutdown

interface hssi 1/0
 ip address 10.1.1.2 255.255.255.0
 hssi internal-clock
 no fair-queue
 no shutdown
```

In this example:

- The **interface hssi** command specifies a HSSI interface and changes the configuration mode from global to interface.
- The **ip address** command assigns an IP address to this interface.
- The **hssi internal-clock** command sets the HSSI clock source.
- The **no fair-queue** command disables fair queueing, which is enabled by default. This optimizes HSSI performance.
- The **no shutdown** command enables the port.

Channelized T3 Interface Processor Configuration Examples

The examples in this section show how to configure the Channelized T3 Interface Processor (CT3IP). The first example shows how to configure two of the T1 channels of the channelized T3 controller. The second example shows how to configure one of the T1 channels of the channelized T3 controller as an external port for further channelization on the Multichannel Interface Processor (MIP).

For more information, refer to the “Configure the T3 Controller” and “Configure External T1 Channels” sections earlier in this chapter. The following examples are included in this section:

- CT3IP Configuration with Default Values Accepted Example
- CT3IP External Ports Configuration Example
- CT3IP Maintenance Data Link (MDL) Example
- CT3IP Performance Monitoring Example
- CT3IP BERT Test Pattern Example
- CT3IP Remote FDL Loopback Example

CT3IP Configuration with Default Values Accepted Example

In the following example, timeslots 1 through 24 (the entire T1 bandwidth) are assigned to T1 channel 16, and timeslots 1 through 5 and 20 through 23 (fractional T1 bandwidth) are assigned to T1 channel 10 for the CT3IP in slot 9. The default framing, cable length, and clock source are accepted for the T3, and the default speed, framing, clock source, and line code are accepted for each T1 channel. Each T1 channel is assigned an IP address. Other interface configuration commands can be assigned to the T1 channel at this time.

```
controller t3 9/0/0
 t1 16 timeslot 1-24
 t1 10 timeslot 1-5,20-23
interface serial 9/0/0:16
 ip address 10.20.20.1 255.255.255.0
interface serial 9/0/0:10
 ip address 10.20.20.3 255.255.255.0
```

CT3IP External Ports Configuration Example

In the following example, T1 channel 1 on the CT3IP in slot 9 is broken out as an external port so that it can be further channelized on the MIP in slot 3. The cable length is 300 feet, and the default line coding format on the T1 channel is used. Because the default line coding format on the T1 channel is B8ZS and the default line coding on the MIP is AMI, the line coding on the MIP is changed to B8ZS.

```
controller t3 9/0/0
 t1 external 1 cablelength 300
controller t1 3/0
 linecode b8zs
 channel-group 1 timeslots 1
interface serial 3/0:1
 ip address 10.20.20.5 255.255.255.0
```

CT3IP Maintenance Data Link (MDL) Example

The following examples show several of the Maintenance Data Link (MDL) messages for the CT3IP in slot 9:

```
controller t3 9/0/0
 mdl string eic Router C
 mdl string lic Network A
 mdl string fic Bldg 102
 mdl string unit 123ABC
```

CT3IP Performance Monitoring Example

In the following example, the performance reports are generated for T1 channel 6 on the CT3IP in slot 9:

```
controller t3 9/0/0
 t1 6 fdl ansi
```

CT3IP BERT Test Pattern Example

The following example shows how to enable a BERT test pattern that consists of a repeating pattern of ones (...111...) and runs for 30 minutes for T1 channel 8 on CT3IP in slot 9:

```
controller t3 9/0/0
 t1 8 bert pattern 1s interval 30
```

CT3IP Remote FDL Loopback Example

The following example shows how to enable a remote payload FDL ANSI bit loopback for T1 channel 6 on CT3IP in slot 3:

```
interface serial 3/0/0:6
 loopback remote payload fdl ansi
```

PA-E3 Serial Port Adapter Configuration Example

The following example shows a typical configuration for serial interface 1/0/0 on a PA-E3 serial port adapter in a Cisco 7500 series router. The **dsu bandwidth** command reduces the bandwidth by padding the E3 frame, the **dsu mode** command enables and improves interoperability with other DSUs, and the **national bit** command sets bit 12 in the E3 frame to 1.

```
Router# configure terminal
Router(config)# interface serial 1/0/0
Router(config-if)# ip address 1.1.1.10 255.255.255.0
Router(config-if)# clock source internal
Router(config-if)# crc 32
Router(config-if)# dsu bandwidth 16000
Router(config-if)# dsu mode 0
Router(config-if)# national bit 1
Router(config-if)# no scramble
Router(config-if)# framing g751
Router(config-if)# no shutdown
Router(config-if)# exit
Router(config)# exit
Router#
```

PA-T3 and PA-2T3 Configuration Example

The following example shows a typical configuration for serial interface 1/0/0 on a PA-T3 serial port adapter in a Cisco 7500 series router. The **dsu bandwidth** command reduces the bandwidth by padding the T3 frame, and the **dsu mode** command enables and improves interoperability with other DSUs.

```
Router# configure terminal
Router(config)# interface serial 1/0/0
Router(config-if)# ip address 1.1.1.10 255.255.255.0
Router(config-if)# clock source internal
Router(config-if)# crc 32
Router(config-if)# dsu bandwidth 16000
Router(config-if)# dsu mode 0
Router(config-if)# no scramble
Router(config-if)# framing c-bit
Router(config-if)# no shutdown
Router(config-if)# ^Z
```

Packet OC-3 Interface Configuration Examples

The examples in this section include a simple configuration and a configuration for two routers back to back.

Packet OC-3 Configuration with Default Values Accepted

In the following example, the default framing, MTU, and clock source are accepted, and the interface is configured for the IP protocol:

```
interface pos 3/0
 ip address 172.18.2.3 255.0.0.0
```

Two Routers Connected Back to Back

To connect two routers, attach the cable between the Packet OC-3 port on each. By default, the POS uses loop timing mode. For back-to-back operation, only one of the POSs may be configured to supply its internal clock to the line.

In the following example, two routers are connected back to back through their Packet OC-3 interfaces:

First router

```
interface pos 3/0
 ip address 170.1.2.3 255.0.0.0
 no keepalive
 pos internal-clock
```

Second router

```
interface pos 3/0
 ip address 170.1.2.4 255.0.0.0
 no keepalive
```

The following example shuts down the entire T1 line physically connected to a Cisco 7500 series routers:

```
controller t1 4/0
shutdown
```

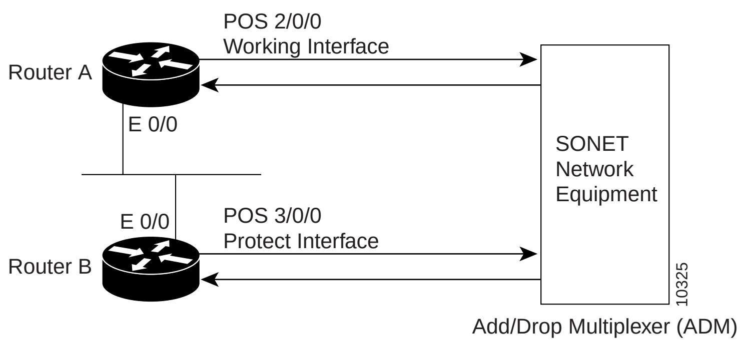
APS Configuration Examples

The following examples show how to configure basic APS on a router and how to configure more than one protect/working interface on a router by using the **aps group** command.

Basic APS Configuration

The following example shows the configuration of APS on Router A and Router B (see Figure 20). In this example, Router A is configured with the working interface, and Router B is configured with the protect interface. If the working interface on Router A becomes unavailable, the connection will automatically switchover to the protect interface on Router B.

Figure 20 Basic APS Configuration



On Router A, which contains the working interface, use the following configuration:

```
Router# configure terminal
Router(config)# interface ethernet 0/0
Router(config-if)# ip address 7.7.7.7 255.255.255.0
Router(config)# interface pos 2/0/0
Router(config-if)# aps working 1
Router(config-if)# end
Router#
```

On Router B, which contains the protect interface, use the following configuration:

```
Router# configure terminal
Router(config)# interface ethernet 0/0
Router(config-if)# ip address 7.7.7.6 255.255.255.0
Router(config)# interface pos 3/0/0
Router(config-if)# aps protect 1 7.7.7.7
Router(config-if)# end
Router#
```

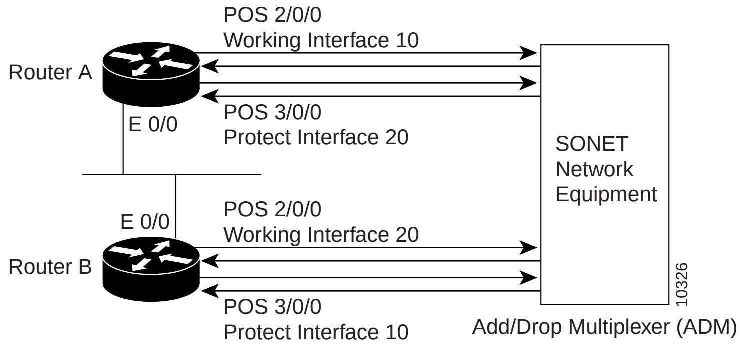
To verify the configuration or to determine if a switchover has occurred, use the **show aps** command.

Multiple APS Interface Configuration

To configure more than one protect/working interface on a router, you must use the **aps group** command. The following example shows the configuration of grouping more than one working/protect interface on a router. In this example, Router A is configured with a working interface and a protect interface, and Router B is configured with a working interface and a protect interface. If the working interface 2/0/0 on Router A becomes unavailable, the connection will

switchover to the protect interface 3/0/0 on Router B because they are both in APS group 10. Similarly, if the working interface 2/0/0 on Router B becomes unavailable, the connection will switchover to the protect interface 3/0/0 on Router A because they are both in APS group 20.

Figure 21 Multiple Working and Protect Interfaces Configuration



Note Configure the working interface before configuring the protect interface to avoid the protect interface becoming the active circuit and disabling the working circuit when it is finally discovered.

On Router A, which contains the working interface for group 10 and the protect interface for group 20, use the following configuration:

```
Router# configure terminal
Router(config)# interface ethernet 0/0
Router(config-if)# ip address 7.7.7.6 255.255.255.0
Router(config)# interface pos 2/0/0
Router(config)# aps group 10
Router(config-if)# aps working 1
Router(config)# interface pos 3/0/0
Router(config-if)# aps group 20
Router(config-if)# aps protect 1 7.7.7.7
Router(config-if)# end
Router#
```

On Router B, which contains the protect interface for group 10 and the working interface for group 20, use the following configuration:

```
Router# configure terminal
Router(config)# interface ethernet 0/0
Router(config-if)# ip address 7.7.7.7 255.255.255.0
Router(config)# interface pos 2/0/0
router(config)# aps group 20
Router(config-if)# aps working 1
Router(config)# interface pos 3/0/0
Router(config-if)# aps group 10
Router(config-if)# aps protect 1 7.7.7.6
Router(config-if)# end
Router#
```

To verify the configuration or to determine if a switchover has occurred, use the **show aps** command.

CSU/DSU Service Module Examples

Two main categories of service module examples are provided:

- FT1/T1 Examples
- 2- and 4-wire, 56/64-kpbs Service Module Examples

FT1/T1 Examples

FT1/T1 examples are provided for these configurations:

- Specify a T1 Frame Type Example
- Specify the CSU Line Build Out Example
- Specify T1 Line-Code Type Example
- Enable Loopcodes Example
- Specify Timeslots Example
- Display a Performance Report Example
- Enable Loopback Line Examples
- Loopback DTE Example
- Setting the Clock Source Example
- TI CSU WIC Configuration Example

Specify a T1 Frame Type Example

The following example enables super frame as the FT1/T1 frame type:

```
service-module t1 framing sf
```

Specify the CSU Line Build Out Example

The following example shows a line build out setting of –7.5 dB:

```
service-module t1 lbo -7.5db
```

Specify T1 Line-Code Type Example

The following example specifies AMI as the line-code type:

```
service-module t1 linecode ami
```

Enable Loopcodes Example

The following interactive example displays two routers connected back-to-back through an FT1/T1 line:

```
Router# no service-module t1 remote-loopback full
Router# service-module t1 remote-loopback payload alternate

Router# loopback remote full
%SERVICE_MODULE-5-LOOPUPFAILED: Unit 0 - Loopup of remote unit failed

Router# service-module t1 remote-loopback payload v54
Router# loopback remote payload
%SERVICE_MODULE-5-LOOPUPFAILED: Unit 0 - Loopup of remote unit failed

Router# service-module t1 remote-loopback payload alternate
Router# loopback remote payload
%SERVICE_MODULE-5-LOOPUPREMOTE: Unit 0 - Remote unit placed in loopback
```

Specify Timeslots Example

The following example displays a series of timeslot ranges and a speed of 64 kbps:

```
Router# service-module t1 timeslots 1-10,15-20,22 speed 64
```

Display a Performance Report Example

The following is sample output from the **show service-module** command:

```
Router1# show service-module s 0
Module type is T1/fractional
    Hardware revision is B, Software revision is 1.1i,
    Image checksum is 0x21791D6, Protocol revision is 1.1
Receiver has AIS alarm,
Unit is currently in test mode:
    line loopback is in progress
Framing is ESF, Line Code is B8ZS, Current clock source is line,
Fraction has 24 timeslots (64 Kbits/sec each), Net bandwidth is 1536 Kbits/sec.
Last user loopback performed:
    remote loopback
    Failed to loopup remote
Last module self-test (done at startup): Passed
Last clearing of alarm counters 0:05:50
    loss of signal        :    1, last occurred 0:01:50
    loss of frame         :    0,
    AIS alarm             :    1, current duration 0:00:49
    Remote alarm          :    0,
    Module access errors  :    0,
Total Data (last 0 15 minute intervals):
    1466 Line Code Violations, 0 Path Code Violations
    0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
Data in current interval (351 seconds elapsed):
    1466 Line Code Violations, 0 Path Code Violations
    25 Slip Secs, 49 Fr Loss Secs, 40 Line Err Secs, 1 Degraded Mins
    0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 49 Unavail Secs
```

Enable Loopback Line Examples

The following example shows how to configure a payload loopback:

```
Router1# loopback line payload
Loopback in progress
Router1# no loopback line
```

The following example shows the output when you loop a packet in switched mode without an active connection:

```
Router1# service-module 56k network-type switched
Router1# loopback line payload
Need active connection for this type of loopback
% Service module configuration command failed: WRONG FORMAT.
```

Loopback DTE Example

The following example loops a packet from a module to the serial interface:

```
Router1# loopback dte
Loopback in progress
Router1# ping 12.0.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 12.0.0.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 8/12/28 ms
```

Setting the Clock Source Example

The following example shows a router using internal clocking while transmitting frames at 38.4 kbps:

```
Router1# service-module 56k clock source internal
Router1# service-module 56k clock rate 38.4
```

TI CSU WIC Configuration Example

The following example shows how to set the fdl parameter to att while in interface configuration mode:

```
panther2(config-if)#service-module t1 fdl att
Exit
CTRL-Z.
panther2(config-if)#<^Z>
panther2#
more system:running-config
.
.
!
interface Serial0/0
 no ip address
 no ip route-cache
 no ip mroute-cache
 no keepalive
 shutdown
 no fair-queue
 service-module t1 clock source internal
 service-module t1 fdl att
 no cdp enable
panther2#
exit
```

2- and 4-wire, 56/64-kpbs Service Module Examples

Examples for 2- and 4-wire, 56/64 kpbs service modules are provided for the following configurations:

- Set the Network Line Speed Examples
- Enable Scrambled Data Coding Example
- Enable Switched Dial-Up Mode Example
- Display a Performance Report Example
- Remote Loopback Request Example
- Select a Service Provider Example

Set the Network Line Speed Examples

The following interactive example displays two routers connected in back-to-back DDS mode. However, the configuration fails because the **auto** rate is used.

```
Router1# service-module 56k clock source internal
Router1# service-module 56k clock rate 38.4

Router2# service-module 56k clock rate auto
% WARNING - auto rate will not work in back-to-back DDS.

a1# ping 10.1.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
.....
Success rate is 0 percent (0/5)

Router2# service-module 56k clock rate 38.4

Router1# ping 10.1.1.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 52/54/56 ms
```

When transferring from DDS mode to switched mode, you must set the correct clock rate, as shown in the following example:

```
Router2# service-module 56k network-type dds
Router2# service-module 56k clock rate 38.4
Router2# service-module 56k network-type switched
% Have to use 56k or auto clock rate for switched mode
% Service module configuration command failed: WRONG FORMAT.

Router2# service-module 56k clock rate auto
% WARNING - auto rate will not work in back-to-back DDS.
Router2# service-module 56k network-type switched
```

Enable Scrambled Data Coding Example

The following example scrambles bit codes in 64-kbps DDS mode:

```
Router# service-module 56k clock rate 56
Router# service-module 56k data-coding scrambled
Can configure scrambler only in 64k speed DDS mode
% Service module configuration command failed: WRONG FORMAT.
Router# service-module 56k clock rate 64
Router# service-module 56k data-coding scrambled
```

Enable Switched Dial-Up Mode Example

The following example displays transmission in switched dial-up mode:

```
Router# service-module 56k clock rate 19.2
Router# service-module 56k network-type switched
% Have to use 56k or auto clock rate for switched mode
% Service module configuration command failed: WRONG FORMAT.
Router# service-module 56k clock rate auto
Router# service-module 56k network-type switched
Router# dialer in-band
Router# dialer string 2576666
Router# dialer-group 1
```

Display a Performance Report Example

The following is sample output from the **show service-module serial** command:

```
Router1# show service-module serial 1
Module type is 4-wire Switched 56
    Hardware revision is B, Software revision is X.07,
    Image checksum is 0x45354643, Protocol revision is 1.0
Connection state: active,
Receiver has loss of signal, loss of sealing current,
Unit is currently in test mode:
    line loopback is in progress
Current line rate is 56 Kbits/sec
Last user loopback performed:
    dte loopback
    duration 00:00:58
Last module self-test (done at startup): Passed
Last clearing of alarm counters 0:13:54
    oos/oof              :    3, last occurred 0:00:24
    loss of signal       :    3, current duration 0:00:24
    loss of sealing curren:    2, current duration 0:04:39
    loss of frame        :    0,
    rate adaption attempts:    0,
```

Remote Loopback Request Example

The following example enables you to transmit and receive remote loopbacks using the **service-module 56k remote-loopback** command:

```
service-module 56k remote-loopback
```

Select a Service Provider Example

The following example selects AT&T as the service provider:

```
service-module 56k network-type switched
service-module 56k switched-carrier att
```

E1-G.703/G.704 Serial Port Adapter Example

The following example shows a configuration for serial interface 9/1/3 on a E1-G.703/G.704 serial port adapter in a Cisco 7500 series router. In this example, the interface is configured for framed (G.704) operation, and timeslot 16 is used for data.

```
Router# configure terminal
Router(config)# interface serial 9/1/3
Router(config-if)# ip address 1.1.1.10 255.255.255.0
Router(config-if)# no keepalive
Router(config-if)# no fair-queue
Router(config-if)# timeslot 1-31
Router(config-if)# crc4
Router(config-if)# ts16
Router(config-if)# exit
Router(config)# exit
Router#
```

Low-Speed Serial Interface Examples

The following configuration examples are provided for low-speed serial interfaces:

- Set Synchronous or Asynchronous Mode Examples
- Change between Controlled-Carrier and Constant-Carrier Modes Examples
- Tune Half-Duplex Timers Example
- Cisco 4000 Series Router with 2T16S Serial Network Processor Example

Set Synchronous or Asynchronous Mode Examples

The following example shows how to change a low-speed serial interface from synchronous to asynchronous mode:

```
interface serial 2
 physical-layer async
```

The following examples show how to change a low-speed serial interface from asynchronous mode back to its default synchronous mode:

```
interface serial 2
 physical-layer sync
```

or

```
interface serial 2
 no physical-layer
```

The following example shows some typical asynchronous interface configuration commands:

```
interface serial 2
 physical-layer async
 ip address 1.0.0.2 255.0.0.0
 async default ip address 1.0.0.1
 async mode dedicated
 async default routing
```

The following example shows some typical synchronous serial interface configuration commands available when the interface is in synchronous mode:

```
interface serial 2
 physical-layer sync
 ip address 1.0.0.2 255.0.0.0
 no keepalive
 ignore-dcd
 nrzi-encoding
 no shutdown
```

Change between Controlled-Carrier and Constant-Carrier Modes Examples

The following example shows how to change to controlled-carrier mode from the default of constant-carrier operation:

```
interface serial 2
 half-duplex controlled-carrier
```

The following example shows how to change to constant-carrier mode from controlled-carrier mode:

```
interface serial 2
 no half-duplex controlled-carrier
```

Tune Half-Duplex Timers Example

The following examples show how to set the cts-delay timer to 1234 milliseconds and the transmit-delay timer to 50 ms.

```
interface serial 2
 half-duplex timer cts-delay 1234
 half-duplex timer transmit-delay 50
```

Cisco 4000 Series Router with 2T16S Serial Network Processor Example

The 2T16S network processor module provides high-density serial interfaces for the Cisco 4000 series routers. This module has two high-speed interfaces that support full-duplex T1 and E1 rates (up to 2 MB per second) and 16 low-speed interfaces. The 16 lower-speed ports can be individually configured as either synchronous ports at speeds up to 128 kbps or as asynchronous ports at speeds up to 115 kbps.

For the slow-speed interfaces, both synchronous and asynchronous serial protocols are supported. For for the high-speed interfaces, only the synchronous protocols are supported. Synchronous protocols include IBM’s BSC, SDLC, and HDLC. Asynchronous protocols include PPP, SLIP, and ARAP for dial-up connections using external modems.

The following example shows a Cisco 4500 router equipped with two 2T16S serial network processor modules and two conventional Ethernet ports. The router is configured for WAN aggregation using X.25, Frame Relay, PPP, and HDLC encapsulation. Serial interfaces 0, 1, 18, and 19 are the synchronous high-speed interfaces. Serial interfaces 2 through 17 and 20 through 35 are the synchronous/asynchronous low-speed interfaces.

```
 version 11.2
!
 hostname c4X00
!
 username brad password 7 13171F1D0A080139
 username jim password 7 104D000A0618
!
```

Ethernet interfaces and their subinterfaces are configured for LAN access.

```
interface Ethernet0
 ip address 10.1.1.1 255.255.255.0
 media-type 10BaseT
!
interface Ethernet1
 ip address 10.1.2.1 255.255.255.0
 media-type 10BaseT
!
```

Interfaces serial 0 and serial 1 are the high-speed serial interfaces on the first 2T16S module. In this example, subinterfaces are also configured for remote offices connected in to interface Serial 0.

```
interface Serial0
 description Frame relay configuration sample
 no ip address
 encapsulation frame-relay
!
interface Serial0.1 point-to-point
 description PVC to first office
 ip address 10.1.3.1 255.255.255.0
 frame-relay interface-dlci 16
!
interface Serial0.2 point-to-point
 description PVC to second office
 ip address 10.1.4.1 255.255.255.0
 frame-relay interface-dlci 17
!
interface Serial1
 description X25 configuration sample
 ip address 10.1.5.1 255.255.255.0
 no ip mroute-cache
 encapsulation x25
 x25 address 6120184321
 x25 htc 25
 x25 map ip 10.1.5.2 6121230073
```

Serial interfaces 2 to 17 are the low-speed interfaces on the 2T16S network processor module. In this example, remote routers are connected to various configurations.

```
interface Serial2
 description DDR connection router dial out to remote sites only
 ip address 10.1.6.1 255.255.255.0
 dialer in-band
 dialer wait-for-carrier-time 60
 dialer string 0118527351234
 pulse-time 1
 dialer-group 1
!
interface Serial3
 description DDR interface to answer calls from remote office
 ip address 10.1.7.1 255.255.255.0
 dialer in-band
!
interface Serial4
 description configuration for PPP interface
 ip address 10.1.8.1 255.255.255.0
 encapsulation ppp
!
 interface Serial5
 description Frame relay configuration sample
```

```
 no ip address
 encapsulation frame-relay
!
interface Serial5.1 point-to-point
 description PVC to first office
 ip address 10.1.9.1 255.255.255.0
 frame-relay interface-dlci 16
!
interface Serial5.2 point-to-point
 description PVC to second office
 ip address 10.1.10.1 255.255.255.0
 frame-relay interface-dlci 17
!
interface Serial6
 description configuration for PPP interface
 ip address 10.1.11.1 255.255.255.0
 encapsulation ppp
!
interface Serial7
 no ip address
 shutdown
!
interface Serial8
 ip address 10.1.12.1 255.255.255.0
 encapsulation ppp
 async default routing
 async mode dedicated
!
interface Serial9
 physical-layer async
 ip address 10.1.13.1 255.255.255.0
 encapsulation ppp
 async default routing
 async mode dedicated
!
interface Serial10
 physical-layer async
 no ip address
!
interface Serial11
 no ip address
 shutdown
!
interface Serial12
 physical-layer async
 no ip address
 shutdown
!
interface Serial13
 no ip address
 shutdown
!
interface Serial14
 no ip address
 shutdown
!
interface Serial15
 no ip address
 shutdown
!
interface Serial16
 no ip address
 shutdown
```

```
!
interface Serial17
 no ip address
 shutdown
```

Interface serial 18 is the first high-speed serial interface of the second 2T16S module. Remote sites on different subnets are dialing in to this interface with point-to-point and multipoint connections.

```
interface Serial18
 description Frame relay sample
 no ip address
 encapsulation frame-relay
!
interface Serial18.1 point-to-point
 description Frame relay subinterface
 ip address 10.1.14.1 255.255.255.0
 frame-relay interface-dlci 16
!
interface Serial18.2 point-to-point
 description Frame relay subinterface
 ip address 10.1.15.1 255.255.255.0
 frame-relay interface-dlci 17
!
interface Serial18.3 point-to-point
 description Frame relay subinterface
 ip address 10.1.16.1 255.255.255.0
 frame-relay interface-dlci 18
!
interface Serial18.5 multipoint
 ip address 10.1.17.1 255.255.255.0
 frame-relay map ip 10.1.17.2 100 IETF
```

This second high-speed serial interface is configured to connect a X.25 link. Serial interfaces 20 through 35 are the low-speed interfaces. However, some of the interfaces are not displayed in this example.

```
interface Serial19
 description X25 sample config
 ip address 10.1.18.1 255.255.255.0
 no ip mroute-cache
 encapsulation x25
 x25 address 6120000044
 x25 htc 25
 x25 map ip 10.1.18.2 6120170073
!
interface Serial20
 ip address 10.1.19.1 255.255.255.0
!
interface Serial21
 physical-layer async
 ip unnumbered e0
 encap ppp
 async mode dedicated
 async dynamic routing
 ipx network 45
 ipx watchdog-spoof
 dialer in-band
 dialer-group 1
 ppp authentication chap
!
interface Serial22
 no ip address
 shutdown
```

```
!
interface Serial23
 no ip address
 shutdown
!
interface Serial24
 no ip address
 shutdown
!
!Serial interfaces 23 through 35 would appear here.
!...

 router eigrp 10
 network 10.0.0.0
!
 dialer-list 1 protocol ip permit
!
 line con 0
 exec-timeout 15 0
 password david
 login
```

The following basic line configuration configures some of the modules' low-speed serial interfaces:

```
line 8 10
 modem InOut
 transport input all
 rxspeed 64000
 txspeed 64000
 flowcontrol hardware
line 12
 transport input all
 rxspeed 64000
 txspeed 64000
 flowcontrol hardware
 modem chat-script generic
line 21
 transport input all
 rxspeed 64000
 txspeed 64000
 flowcontrol hardware
!
 end
```